ENGINEERING NEWS-RECORD

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In the News:

ANOTHER DRAFT of the code for the engineers' division of the construction industry has been submitted to the NRA. It follows closely the draft submitted late in March in all respects except those outlined in our news pages this week. Methods of practice are redefined in order to eliminate objections raised since the March 22 draft was published. The wording of other sections has been altered to clarify their meaning.

REFUNDING of $280,000,000 of bonds, maturing within the next ten years, into 30-year bonds has just been completed by the city of Detroit. Said to be the largest municipal refunding operation on record, it greatly improves Detroit's financial position, reducing the debt burden from $32,000,000 to $8,000,000 for the next fiscal year.

PWA-FINANCED road work, under the $400,000,000 allotment, is progressing rapidly; 85 per cent is under way or complete. Projects total 7,315, direct employment 130,734 men.

GRAND COULEE Dam and power plant on the Columbia River, 100 miles west of Spokane, Washington, will furnish another huge construction project. Bids, to be opened on June 18, will provide for the placing of 3,260,000 cu.yd. of concrete, among other items. Boulder Dam (exclusive of tunnels, power house, etc.) will contain 3,400,000 cu.yd., which gives some idea of the yardage involved for all purposes at Grand Coulee.

HEARING on the ten-billion-dollar La Follette public-works bill brought out many instances of need for prolonging the PWA—and a number of suggestions for changing some of the past practices of that organization.

In This Issue:

LOW COST and pleasing appearance are combined in Rhode Island's new Stillwater Viaduct, a concrete structure on a bypass road around Providence; 450 ft. long and providing for four lanes of traffic, it was built for $3.25 per square foot.

OUT OF SIGHT, out of mind is the theory back of the placing of 300,000 cu.yd. of earthfill on the downstream side of Mulholland Dam, a gravity concrete structure near Hollywood, Calif. Although pronounced adequately safe after several investigations, residents below it still could not forget the St. Francis Dam disaster. The new fill will hide all but the top 35 ft. of the 210-ft.-high dam.

THE SECOND ARTICLE on vibrated-concrete-pavement experience includes data from Ohio, Illinois and New Jersey, as well as a discussion of equipment requirements. It gives further proof of the potential advantages of vibration.

INTERLINING, with corrugated metal pipe, a concrete culvert that had cracked and settled under the weight of a levee embankment solved a difficult repair problem at Helena, Ark. The construction methods are outlined in an article in this issue.

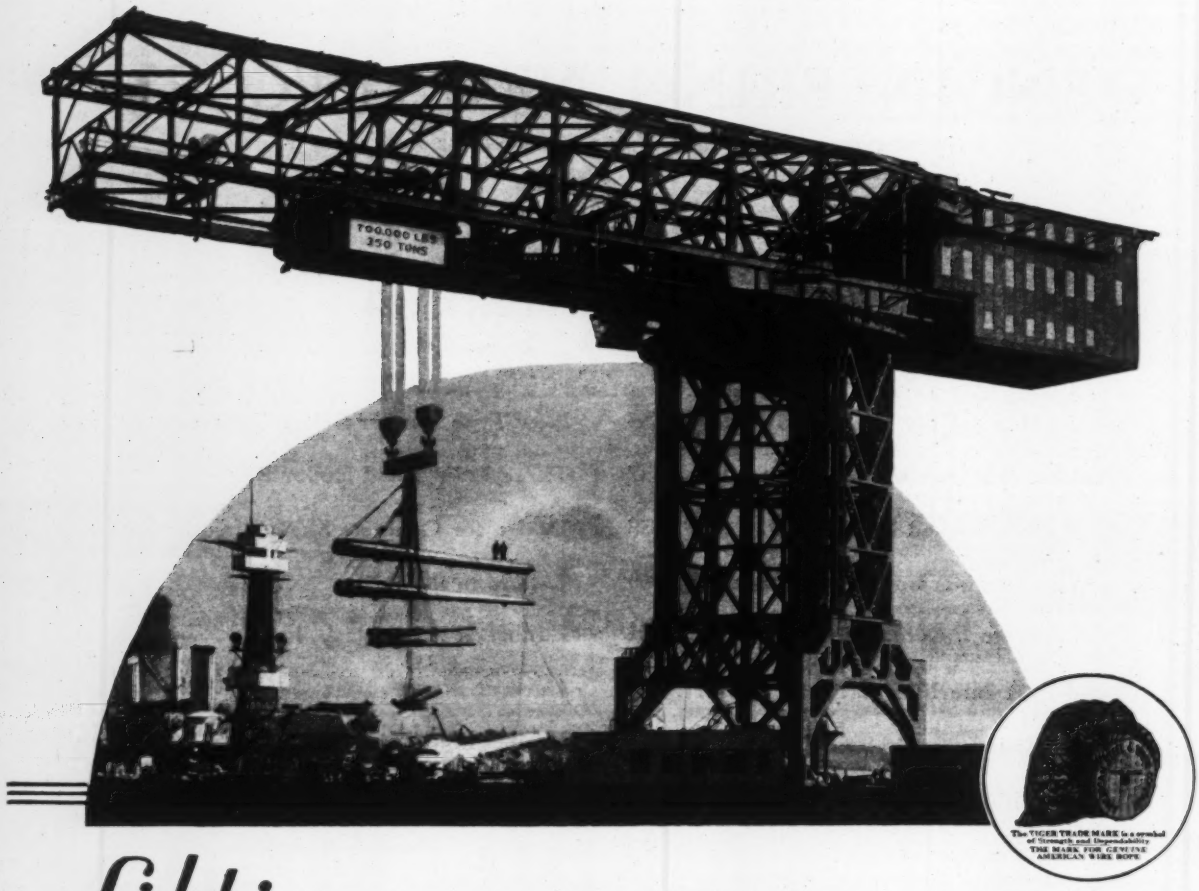
TIMBER HIGHWAY BRIDGES have been built in increasing numbers during the past two years, and particularly since secondary-road development became active. A county bridge in Ohio utilizes a a multi-ply truss, made up of truss members alternating with diagonal sheathing. Increased strength and weather resistance are two important advantages that are claimed.

WELL WATER for Dresden, Germany, is augmented by pumping water from the Elbe River, settling and filtering it and then allowing it to seep into the ground. Manganese is removed by a biological process.

Coming Articles:

DEEP PIERS for a bridge over the Mississippi River at New Orleans are being sunk by the same method as was used successfully on the Suisun Bay Bridge piers in California. Greater depths are required to reach a firm foundation in the Mississippi River silts. The methods of sinking the pier caissons through artificial sand islands by open-dredging to depths up to 170 ft. will be described in next week's issue.

PORT DEVELOPMENT is represented in its most modern phase by two articles on the improved Port of Havre, which are scheduled for early publication. This ancient French seaport is being modernized on the theory that the modern port is a mechanism for quick and cheap interchange of ocean and inland traffic and for the development of all the industries that serve this purpose. The first article will outline the design characteristics of the work, while the second will be devoted to the construction operations, some of which were difficult and unusual.



Lifting 700,000 POUNDS

LOCATED at the Puget Sound Navy Yard—this giant Hammerhead Crane, erected by the Dravo Contracting Company, lifted with ease a test load of 350 tons. Supporting this vast weight—and chosen for its proved strength and dependable performance—was American Steel & Wire Company Wire Rope. This product is in general use wherever uninterrupted service and economy are vital factors. If you are interested in lower operating costs and greater efficiency—if you want true and proved value—it will pay you to use American Steel & Wire Company Wire Rope on your present and future jobs.

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ENGINEERING NEWS-RECORD

May 3, 1934

New York

FIG. 1—STILLWATER VIADUCT in Rhode Island, a four-lane H-20 structure with eight T-beam approach spans and an open-spandrel, three-rib arch of 80-ft. span over the Woonasquatucket River on the new Washington Highway that bypasses Providence.

Low Cost Achieved on Heavy-Duty Highway Bridge

Rhode Island builds Stillwater Viaduct, with special attention to appearance and simplified details, for $3.25 per sq.ft. including pavement

By D. O. Cargill

Bridge Engineer, Rhode Island State Board of Public Roads, Providence, R. I.

A HIGHWAY bridge recently completed by the Rhode Island board of public roads exemplifies several ideas of increasing importance to bridge and highway engineer as follows:

First, the bridge was completed at a cost of $3.25 per sq.ft. of deck area, including the roadway paving. This is believed unusually low for such a structure, considering its height and loading.

Second, both the design and the location of the structure were influenced more by the criteria of highway grade and alignment than the economics of the structure itself.

Third, particular care was taken to secure a structure of fine appearance.

Fourth, certain details of design were adopted to preserve the appearance against disfiguration by storm and weathering.

The structure, known as the Stillwater Viaduct, is located in Smithfield, R. I., and carries the Washington Highway across the Woonasquatucket River and over the single track of the Pascoag Branch of the New York, New Haven and Hartford Railroad. The Washington Highway, as partly constructed, forms the north-to-west sector of a circumferential route skirting the metropolitan area of Providence and adjoining cities. When completed, this highway will connect the radial routes on the Rhode Island system as well as those of the adjacent Massachusetts system entering this area.

Strictly from the standpoint of structural design, a more advantageous crossing of the valley is to be found about 1,000 ft. downstream from the present location, which was selected to permit straight approaches. A 3 per cent gradient was established to serve the Farnum Pike intersection at grade at a point about 800 ft. from the west and lower end of the structure. Later on, a grade-separation structure may be built at the Farnum Pike intersection with an equally suitable grade to the viaduct. In accordance with an established policy under such conditions, the necessary land has already been acquired for such second-stage construction.

The Stillwater Viaduct has an overall length of 449 ft., with a four-lane roadway 40 ft. wide, and two sidewalks each 4.5 ft. wide. It was designed for H-20 live loading with the compressive strength of Class A concrete taken at 3,000 lb. per sq.in. The bridge consists of eight approach spans of T-beam type, varying from 33 to 42 ft., and an 80-ft.

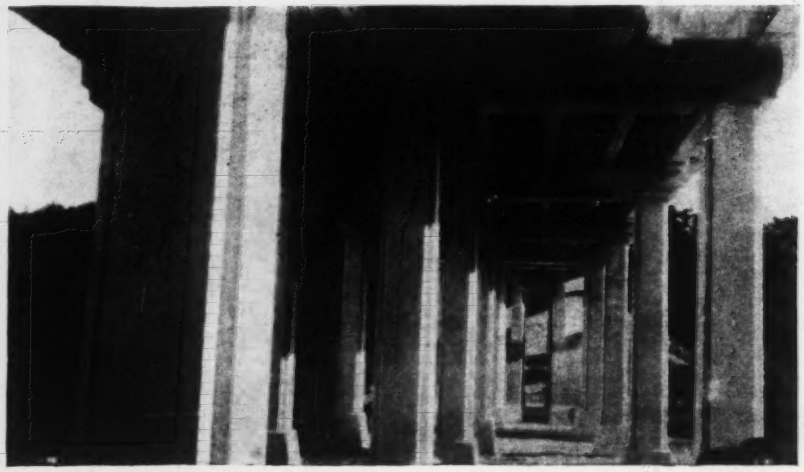


FIG. 2—SIMPLIFIED DETAILS of columns, caps and beams contribute to neat appearance and provide maximum resistance to weathering.

open-spandrel three-rib arch over the stream. The arch ribs have a thickness of 4 ft. at the springing line and 1.5 ft. at the crown.

The footings on the east side of the river were carried to sound ledge rock, which was exposed over most of the area. On the west side of the river the footings are carried into hardpan formation. The approach decks are carried on reinforced-concrete bents made up of three columns and a cap. The end bents are open, with no lateral or longitudinal braces except knee connections to foot blocks and caps. The embankments find their own slope, with neither abutments nor wing walls to retain them.

Attention to details

Careful thought was given to the general appearance of the bridge, not only in proportioning and spacing members but also in details. The corners of the posts are deeply beaded and chamfered, and caps are corbeled out to provide proper seating of fascia girders, combining good appearance with an efficient use of material. Also, measures were adopted to prevent staining and disfiguration from weather and drainage, and thus preserve the good general appearance of the bridge. For this purpose the railing base, brackets and fascia of beams were provided with drip elements or arrises that harmonize with the general lines of the structure and carry surface water away from lower surfaces. To prevent water that might seep below deck level from dripping on the lower portions of the bridge, the flashings for expansion joints were extended well out between the twin brackets over each bent.

The fascia girders are deeper than the interior beams, to be in proper proportion to the general dimensions of the structure, and for the sake of uniformity have constant depth from end to end of the bridge. They also carry the extra load of the brackets, sidewalk and concrete railing.

Provision for contraction and expansion is made over each pier. If anything, this has been overdone both in the floor beams and the deck. Somewhat lower cost might have resulted by alternating fixed and sliding ends over the bents. During the unusually protracted low-temperature periods of the past winter season the major motion from contraction in the deck system occurred at the ends of the arch span a[t] at about the mid-point in the longer a[p]proach. Deck joints of course must [be] provided but in general should be k[ept] to the minimum, as they can easily b[e] source of trouble. The sliding bearing[s] are composed of a stainless-st[eel] masonry plate and a rolled phosph[or] bronze sole plate, both $\frac{1}{4}$ in. thick.

One somewhat unusual provision [is] a cantilevered smoke deflector proje[ct]ing from the fascia girders over t[he] railway tracks. This is intended to i[m]pede the blackening of the girders a[nd] bridge rail and so far has been succe[ss]ful, although it is expected that in ti[me] drifting soot will cause some discolor[a]tion.

Provision has been made for futu[re] lighting of the roadway. Conduits a[nd] blind recesses for a parapet type [of] luminary and controls were built in[to] the railings, also anchorages for ligh[t]ing standards as an alternate or co[m]bined installation.

Complete control of the quality [of] concrete resulted in a seven-day com[-]pressive strength (average of all jo[b] cylinders) of 2,919 lb. per sq. in.; and at 28 days, 4,402 lb.

The construction work was carried on without any unusual incidents, the methods being along conventional lines of practice for this type of concrete work. Very good results were obtained by the use of $\frac{5}{8}$-in. 5-ply Douglas fir treated for use in concrete form facings, particular care being taken to avoid deflections and to maintain the true lines of the structure. The exposed surfaces were finished easily by hand-rubbing with carborundum bricks, only fresh water being applied to the surface. This produced a very uniform surface texture and appearance.

Testing forms for distortion

The subject of material for forms, their construction and inspection is worth more extended comment. The following is quoted from the forthcoming annual report of the Rhode Island State Board of Public Roads Bridge Department for 1934:

There have been many developments toward simplification and improvement of

FIG. 3—BRACKETS are designed to shed water drippings. Note square edge of shallow pad at bracket tip to divert water from bracket soffit; also inclination of bracket heal away from beam face.

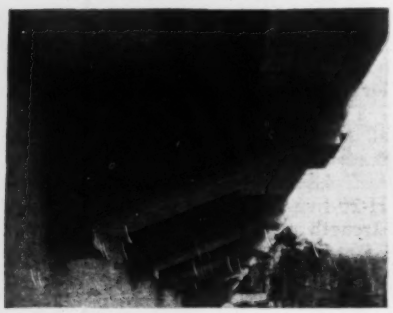


FIG. 4—CONTRACTION JOINT over brackets. In railing there is a joint in the cap only. The rail base is continuous over three panels and is reinforced against bending negative moment.

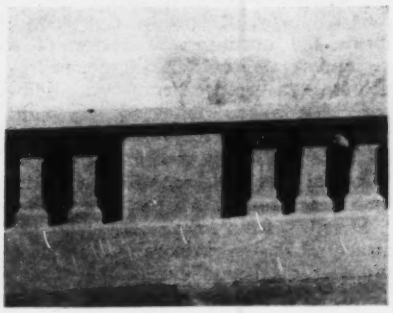
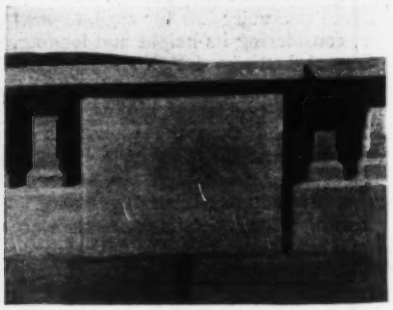


FIG. 5—MAJOR EXPANSION in the viaduct is taken care of by open joints in both rail base and cap, shown to the right of the wide post or pilaster. The sidewalk joint is bituminous-filled.



form construction in recent years. Among the materials now available are large sheets of pressed-wood fiber and of laminated wood specially treated for resistance to the moisture from the concrete. They have a considerable advantage over boards in the reduction of joints in the form facing which ordinarily produce irregularities in the surface of the concrete. Slight waves and irregularities in concrete surfaces are very noticeable in bridge structures where bright sunlight and deep shadow lines emphasize the imperfections that otherwise might pass unnoticed. The continuity of the panels adds a degree of stiffness and resistance to distortion that is desirable, but the economical use of the new materials, which are thinner than materials formerly used, involves the proper design and correct spacing of the supporting framework.

As a check on the computed design, we have developed a piece of apparatus in our laboratory by means of which a hydraulic pressure equal to the anticipated concrete load may be applied to an actual specimen of the proposed form, and minute distortions measured by dial indicators. This apparatus at one and the same time tests the panel facing, the studs, the rangers and ties as planned for under field working conditions, avoiding any guesswork as to the chance of producing an unsatisfactory concrete surface through bulging.

The device referred to can be of particular value in settling disputes over the adequacy of forms, particularly in the case of tall slender columns when the forms are subject to high fluid pressure, if the concrete must be placed continuously and vibrated during placement. Such conditions bring about pressures not commonly experienced on forms for ordinary construction. With the device mentioned, a 2x4-ft. panel of form material can be tested for pressures up to 50 lb. per sq. in.

The total structural cost of the Stillwater Viaduct, exclusive of roadway pavement, was $69,715, or $2.98 per sq.ft. of superficial deck area. Including 2½-in. asphalt block pavement, the total square-foot cost was $3.25.

The bridge was built by C. W. Blakeslee & Sons, Inc., New Haven, Conn., with William Powell as superintendent. Design and supervision were under direction of the writer, with J. A. Russo in charge as resident engineer, and Francis J. Johnson as bridge construction engineer.

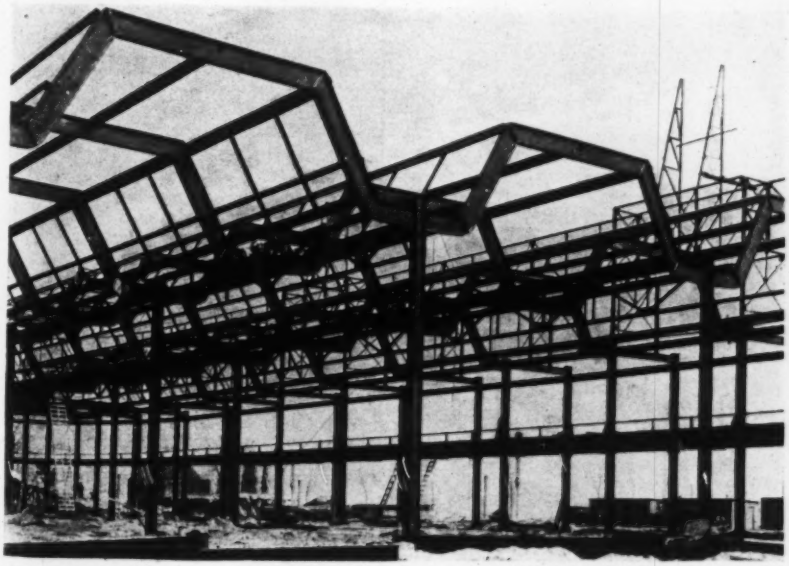
Novel Welded Frames Used in Monitor Roof Construction

IN THE NORTH WING of the new building being built to house the exhibits of the Ford Motor Co. at the Century of Progress this summer in Chicago, there are three 40-ft. bays in which a novel type of monitor roof construction is being used. This consists of continuous welded frames made up of 21-in. I-beams, as shown in the accompanying views, and was developed by the architect in order to eliminate the usual maze of steelwork presented by built-up monitor roof trusses.

An interesting method was used in forming the lower hip joint, to maintain the continuity. Triangular notches were first cut through one flange and the web of the beam, with the desired radius cut in the web above the other flange, as shown in Fig. 2. The beams were then bent until the two web edges joined. A reinforcing strut was then placed on each side of the web and the whole welded with a §-in. bead. At the top hip joint the web was cut entirely through, but the continuity was maintained by welding, and a reinforcing strut was used, as shown in Fig. 1.

The building was designed by Albert Kahn, Inc., Detroit, and the steel contract was handled by the R. C. Mahon Co., of Detroit. The cutting was done on a special pantograph cutting machine designed and built by the contractor.

FIG. 1—SPECIAL MONITOR ROOF CONSTRUCTION on the new Ford exhibit building at the Century of Progress.



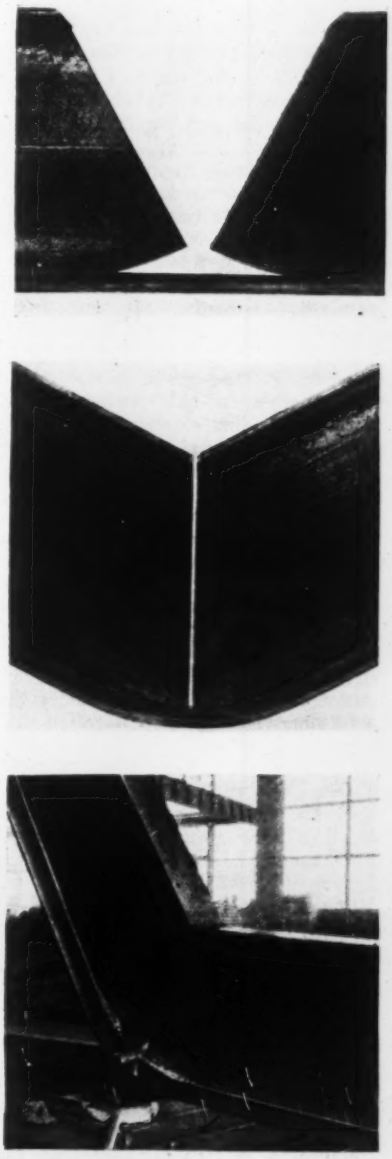


FIG. 2—THREE VIEWS showing the fabricating steps in bending and welding the 21-in. I-beams of the monitor frames.

Mulholland Dam Backed by Earthfill Against Downstream Face

Public sentiment overrides engineering opinion as to safety of Los Angeles water-supply structure—Subsequent landscaping will practically conceal the dam from Hollywood

CONCEDING to the pressure of public opinion, in the face of a preponderance of technical opinion that declared the structure adequate in foundation and design, an earthfill has been placed against the downstream face of the Mulholland Dam by the Los Angeles bureau of waterworks and supply. The dam is located in Weid Canyon above and in plain view of Hollywood. Since the failure of the St. Francis Dam in 1928, Hollywood residents have protested, with varying public support, against the maintaining of the 7,437 acre-ft. of storage in this reservoir, which is of primary importance in meeting emergency demands on the distribution system. As a result, 300,000 cu.yd. of earthfill have been placed on and against the downstream face, and this slope will be planted to trees and shrubs, practically concealing the dam from Hollywood.

The most serious question involved in the possible abandonment of this reservoir, as was demanded, was its strategic location providing storage and pressure for the water-supply system in the midst of a thickly settled area. Any emergency demand in time of fire or rupture of service mains made the continuance of this reservoir essential. Repeated studies failed to find any other natural storage site or economic pumping alternative that would supply the same protection for the area served by the Mulholland Reservoir.

The dam was built in 1924-1925, according to the city's design, under the same supervision and organization that built the numerous other structures in the extensive Los Angeles water-supply system. The watershed area behind this reservoir is small, and the reservoir is supplied with water piped in from other sources. The dam is a concrete structure, 200 ft. high above the foundation, with a crest 933 ft. long by 16 ft. wide, extended by corbels to provide a roadway width of 20 ft. The upstream face has a batter of 1 in 27, and the average slope of the downstream face is 2 horizontal to 3 vertical for a vertical distance of 130 ft. below the crest, to keep the pressure resultant inside the middle third with water level at top of dam. Below this elevation the slope is flattened to limit the foundation pressure to 10 tons per sq.ft. at the downstream toe and 12 tons at the upstream toe. The dam is curved in plan (upstream radius 550 ft.), but was designed as a gravity structure. It contains 175,000 cu.yd. of concrete.

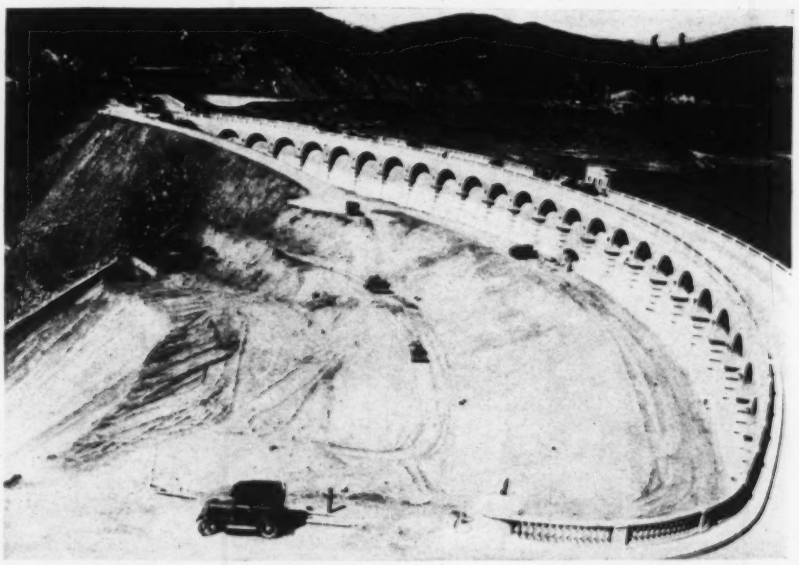
Immediately after the failure of the St. Francis Dam in 1928, Hollywood residents became highly apprehensive about the Mulholland Dam. The more aggressive objectors claimed it was not safe, and vigorous criticism was centered on city officials who permitted the continued use of the reservoir. In August, 1928, a suit was filed against the city to force the abandonment of the reservoir, on the ground that it constituted a menace to life and property. The plaintiffs contended that the dam lacked cutoff walls, inspection gallery, contraction joints and sufficient drainage, and that if the structure failed great loss of life and property would result.

Meantime, during the summer of 1928 and later, consultants were engaged by city and state to restudy the various dams built by Los Angeles. Special attention was directed to Mulholland Dam because all were cognizant of the serious result that would arise from any failure of this structure. The findings of the several boards of engineers and geologists that examined the dam are summarized in the following:

First Report—A consulting board consisting of A. J. Wiley, Boise, Idaho; F. [illegible] Herrmann, San Francisco, and Charles H. Paul, Dayton, Ohio, appointed by the Los Angeles city council in 1928 to report on the condition of the 29 dams of the city's water department, reported in reference to the Mulholland (then called Hollywood) Dam that: "It is our judgment, therefore, that the dam is a safe and permanent structure." The statement of F. L. Ransome, professor of economic geology, California Institute of Technology, who assisted in the preparation of the report, closed: "Conclusion: From the geological point of view, the full consideration of the possibility of future fault movement and earthquakes, and with respect to attitude and character of the foundation rock, it is concluded that the Mulholland Dam occupies an excellent site. The geological examination has not only failed to disclose any weakness in the site but has been decidedly reassuring along every line of inquiry that appeared likely to throw any light upon the question of the permanence of the structure."

Second Report—A consulting board appointed by the Los Angeles board of water and power commissioners on May 11, 1928, to report on the condition of the Mulholland Dam, consisted of L. C. Hill, Los Angeles, R. E. McDonnell, of Burns & McDonnell Engineering Co., Kansas City, Mo., and R. T. Hill, geologist, Los Angeles. It reported in October, 1928, that the foundation was secure and the dam structurally adequate and safe with reservoir full. "Foundation pressures and stresses in the concrete are low, and resistance to sliding on the base, even considering full uplift, is 0.67. . . . Any seismic disturbance which would seriously affect the dam would be of such intensity as to destroy Hollywood completely and render the failure of the dam of little consequence."

FIG. 1—PLACING 300,000 cu.yd. of earthfill against the downstream face of the dam. Fill material was moved from adjacent sidehills by trucks and end-dumped from both abutments. Top of fill is at final height. The finished 3-to-1 slope will be planted to trees and shrubs.



The conclusion of the geologist on the board was: "The Mulholland Dam and reservoir present no geological conditions which render them defective or unsafe."

State Investigation—As a result of the California Dam Control Act of 1929, the state engineer appointed a consulting board to report on the safety of the dam in January, 1930. This board consisted of G. A. Elliott, San Francisco, J. L. Savage, U. S. Bureau of Reclamation, Charles P. Berkey, professor of Geology, Columbia University, New York, G. D. Louderback, professor of Geology, University of California, and Ira A. Williams, consulting geologist, Portland, Ore. The conclusion reached by this board and filed with the state engineer, June, 1930, stated: "In accordance with its purpose, the board has based its opinion entirely on engineering and geological data and considerations. A favorable location in Weid Canyon was selected for this dam, and the precautions taken in construction were sufficient to meet the actual engineering needs. Although the foundation rock is affected by small fault slips, its physical condition is otherwise good, and there is no reason to expect that it will deteriorate appreciably due to the conditions imposed by water storage. In the opinion of the board, therefore, the Mulholland Dam is safe." As a result of this report no action was taken by the state engineer's office in requiring modification in the structure or change in operation of the reservoir.

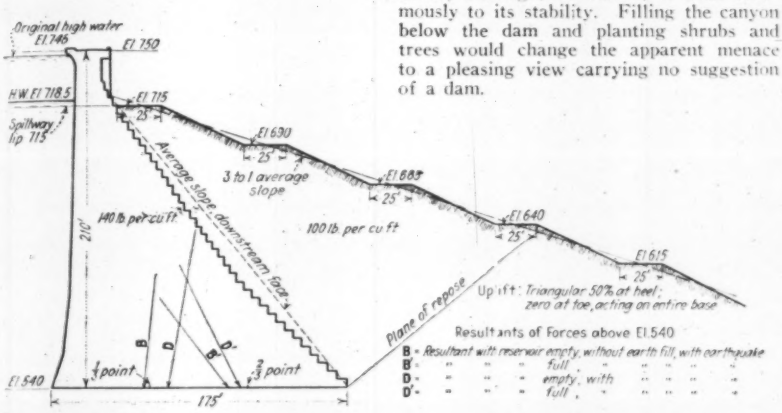

Original high water
El. 746
El. 750
H.W. El. 718.5
Spillway lip 715
El. 715
El. 690
El. 665
El. 640
El. 615
25'
3 to 1 average slope
Average slope downstream face
140 lb. per cu ft.
100 lb. per cu ft.
Plane of repose
Uplift: Triangular 50% at heel; zero at toe, acting on entire base
El. 540
1/3 point
2/3 point
175'
Results of Forces above El. 540
B = Resultant with reservoir empty, without earth fill, with earthquake
B' = " " " full, " " " "
D = " " " empty, with " " "
D' = " " " full, " " " "

FIG. 2—MAXIMUM SECTION through ten-year-old Mulholland Dam, showing recently placed earthfill with the position of the force resultant for several of the analyses.

Report Recommends Lower Spillway—A consulting board consisting of L. C. Hill and A. L. Sonderegger, consulting engineers of Los Angeles, and H. A. Van Norman, general manager and chief engineers of the Los Angeles department of water and power, was appointed in March, 1930, by the board of water and power commissioners. This board received instructions to study the problem from the standpoint of reservoir operation in connection with the water-supply system of the Hollywood district. In reference to the necessity of the storage as a part of the protection for the Hollywood area, the board found that "under no condition is it safe to eliminate the Hollywood (Mulholland) reservoir." In reference to the possibility of strengthening and increasing the safety of the structure, the board stated that: "If a properly built earth and rock fill (of ample dimensions) is placed downstream and against the Hollywood (Mulholland) Dam, it would, of course, add to its stability when the reservoir is full and would bring the resultant of all pressures nearer the middle of the dam, both when the reservoir is full and when empty, and make it impossible for the dam to fail if subjected to an earthquake shock great enough to destroy Hollywood. If the water is held at El. 715 (31 ft. below original spillway level), the resultant will pass about through the middle of the base.

"Practically, the great advantage of this fill would be the psychological effect produced, although, of course, it adds enormously to its stability. Filling the canyon below the dam and planting shrubs and trees would change the apparent menace to a pleasing view carrying no suggestion of a dam.

"We therefore recommend that a properly built fill having a very flat slope be placed below and against the Mulholland Dam, and that when finished it be planted and landscaped."

This report was filed on March 7, 1930, and as a result application was made to the state engineer and approval was granted for placing the suggested earth blanket on the downstream face and lowering the spillway to El. 715. The spillway was cut down to the 715-ft. level in March, 1932.

An Adverse Report and Dr. Berkey's Reply—The problem arising from continued public pressure requesting abandonment of the reservoir, on one hand, and the absolute necessity of this storage for adequate water supply in the district on the other, resulted in the appointment of another consulting board by the water and power commissioners in April, 1931, which was to report not only on the adequacy of the structure but on a plan for serving the area from other sources of supply. This board consisted of B. F. Jakobsen and C. T. Leeds, consulting engineers, Los Angeles, and Allen E. Sedgwick, consulting geologist, Los Angeles. This board failed to agree in its final report and presented two separate opinions.

Mr. Jakobsen concluded that the dam contained deficiencies in structure, and Mr. Sedgwick stated that it rested on geological faults. In this majority report the structure was stated to be insufficient as to base width, lacking in provisions against uplift and earthquake stress, and deficient in respect to preparation of the foundation against sliding. The report also stated that there was insufficient drainage in the foundation, that no drainage was provided in the structure and that the stored water surface should be lowered to El. 695.

Colonel Leeds in the minority report declared that the dam was safe and approved use of full storage capacity to the present spillway level. Both reports also discussed the provision of substitute service to the Hollywood district by putting in larger distribution mains and increased use of some of the distribution reservoirs in the system. These data, not being directly involved in the present discussion, are not included in this abstract.

Following Mr. Sedgwick's geological report, Dr. Charles P. Berkey re-examined the ground at the dam and reported as follows: "I have reviewed the geological data of the Mulholland Dam site and have re-examined the ground at the dam and the necessary additional ground in an attempt to determine whether any important revision of opinion ought to be made. The significant features have all been seen before. In my opinion nothing has been discovered or developed to throw any doubt on the almost unanimous opinion of the several geologists who have examined this site that geologically it is safe. The chief points of dissent in the single report venturing an adverse opinion are, in my judgment, inadequately supported by field evidence."

These findings, preponderantly for the safety of the structure, carry the weight of expert opinion from engineers selected to represent the state department of engineering and from men called in from other states—in short, men who could not have been influenced to favor the dam. Despite this, and even after suit against the city to force abandonment was finally dismissed on request of plaintiffs, a lingering fear of the dam has persisted in the Hollywood district.

Meantime, the importance of this particular site for a local storage reservoir has become more evident, and city officials have become convinced that it would be unjust to taxpayers to sacrifice the advantage of and the investment in this reservoir solely to quiet objections that have so little basis for their charges of insecurity.

Taking all these facts into consideration last year, the city decided (1) to place the downstream blanket already approved by the state engineer; (2) to landscape the surface of the fill, thus presenting a pleasing appearance as viewed from Hollywood; and (3) henceforth to make unrestricted use of the reservoir for storage up to El. 715 (spillway level). The accompanying cross-section shows the effect of the fill on the original pressure resultant, all resultants being figured for the gravity-dam section, independent of arch effect.

Earthfill placed

To prepare the downstream toe for the fill, the surface was first stripped to bedrock, the necessary outlet and drainage pipes were laid and encased in concrete. These pipes include a 60-in. outlet from the reservoir, a 45-in. and an

18-in. line from small storages at higher levels, and a 30-in. line to lead off drainage from under the concrete dam and the earthfill.

The spillway put in in 1932 (El. 715) was made in the center of the dam. When the earthfill was placed, this central spillway was closed and a semi-circular spillway was built against the west end of the dam, with overpour lip at El. 715. The new spillway shaft leads down to an outfall tunnel 6 ft. in diameter. This spillway, with a 2-ft. depth of overpour, has a capacity of 400 sec.-ft.

Suitable material for the fill, which required a total of 300,000 cu.yd., was available on city property above the dam with an average haul of about 1,200 ft. Using the roadway around the reservoir and across the dam, power shovels, trucks and bulldozers were used to move the material from the hillsides above the dam and place it in bench fills begun at either end of the dam and extending outward until they met in the center of the canyon. Overcasting from the top continued throughout the job, although as the work progressed it was economical to build construction roads along the edges of the fill leading to lower levels to avoid rehandling material after original dumping. The lower part of the fill, up to a height of 100 ft. above the foundation, was jetted to aid compacting and add stability to the toe during settlement.

Blasting was necessary to loosen much of the fill material, the ratio being about 60 per cent sandstone and 40 per cent earth and loose material. No blasting was permitted in the stripping operations below the dam. The maximum depth of fill is 165 ft. The allowance made for settlement was 2 per cent of volume, equalling about 0.8 ft. for maximum depth. The work was started May 1, 1933, and on April 1, 1934, it was scheduled for completion within the next two weeks. The cost of the entire job was about $250,000.

The work has been done under the general direction of H. A. Van Norman, general manager and chief engineer of the Los Angeles bureau of waterworks and supply.

Cities in West Virginia Slowly Improve Finances

WEST VIRGINIA'S municipalities are still without adequate revenues to pay for many current activities, but revenue has been assured to care for interest and amortization on bonded indebtedness and indebtedness legally contracted prior to May 22, 1933.

Their condition is much better than it was for a number of months, however, for then no taxes could be collected at all, pending final legal adjudication of the state constitutional amendment limiting tax levies. Indeed, for a number of months, complete paralysis of municipal activities seemed imminent, and many city councils served formal notice on city employees that they must work without definite assurance of compensation.

Partial relief finally came Feb. 27, when the State Supreme Court of Appeals upheld an act passed by an extraordinary term of the legislature Feb. 19, which provided that 30 per cent of the revenue resulting from the curtailed direct-tax levies must go to pay interest and sinking fund on bonded indebtedness, and that 70 per cent, and no more, could be used for operating expenses.

A most important part of the decision allowed excess levies to be imposed, where necessary, to meet bonded obligations. This apparent nullification of the new constitutional provision, limiting levies to 50c., $1, $1.50 and $2, on the four different classes of property, was justified on the ground that the validity of a contract must not be destroyed.

Due to lack of revenue, even under the new law upheld by the latest court decision, almost every city in the state has been compelled to reduce its operating budget to a bare subsistence level. Libraries have been closed, or turned over to civic organizations. Garbage collection is merely a memory in many municipalities. Police forces have been skeletonized. Utility bills for street lighting and for fire protection have gone for months without settlement. This state of affairs becomes more understandable when it is known that on business property, on which highest tax rates are imposed, a levy of only 35c. per $100. is available to the cities for meeting current expenses.

The financial condition of counties, is perhaps better than at any time in years, however, as the portion of the permissible levy assigned to them is more than adequate, since the state has taken over the entire school and road systems, leaving school and road districts with only old debts and bond obligations to meet.

West Virginia cities had expected permission to impose special sales taxes, or to be given the right to sell city license tags for automobiles, but the legislature took the retail sales-tax idea and appropriated it for the purpose of meeting requirements for educational and relief purposes, and adjourned without seriously considering the plight of the municipalities. There is much agitation for another special session.

This agitation for real relief will become stronger as one city after another uses up all its cash. The collection of delinquent taxes has carried many municipalities safely through the past few months. The revenue from semi-annual direct-tax payments, with the restrictions and limitations noted above, is just beginning to come in now.

Regardless of the outcome, those doing business with any West Virginia governmental unit will watch their step, for the new statutes clearly state that expenditures made in an unauthorized manner for an unauthorized purpose, in excess of the levy allocation or in excess of funds on hand, are void. Obligations contracted in any such manner may be nullified by court action; and/or the money may be recovered from the responsible official. In addition, fines, imprisonment and loss of office are imposed as penalties.

Provision was made in another act for the liquidation of legally contracted indebtedness contracted prior to May 22, 1933, not reduced to judgment or not in bond form. It will be discussed later.

Instrumentalities have been set up by law to provide for the adjudication of the validity of *unbonded* indebtedness, such as claims to road contractors, etc. House bill 274, passed Jan. 26, allows a total of ten years, if necessary, for the payment of claims that are allowed. Holders of these claims had feared for a time that they would not realize at all, due to the judicial interpretation of the levy-limitation amendment.

Work Begun on New Automobile Highway in Bavaria

Construction work has begun on the new automobile highway between Munich, Bavaria, and Salzburg, Austria. As Salzburg lies exactly on the Bavarian-Austrian border, the road will be entirely within the state of Bavaria.

Nearly the entire length of the road, some 122 km., will be new construction. Final estimates of the costs have not yet been completed, but a credit of 50,000,000 marks has already been granted by the German Federal Railways to the German Auto Highway Commission to carry on the work. It will require from two to three years to complete the road. It is estimated that several thousand workmen will find employment for the greater part of that time in the highway construction.

An interesting feature of the road will be the new bridge over the River Inn at Pfraundorf, a few kilometers east of Rosenheim.

Vibrated Concrete Pavements—II

Second of two groups of articles on consolidating pavement concrete by vibration, including Ohio and Illinois experiments, a summary of experience in New Jersey and a discussion of equipment requirements

STUDY of vibration for compacting pavement concrete has extended materially beyond formal determinations of strength and density. It has considered also the economics of speed of construction and reaction on organization and equipment of vibratory paving operations. The group of articles in this issue stresses these elements. Observation and experience are recorded in broader terms than are given by the dials of the testing machine.

Attention is directed in particular to equipment of paving operations—first to the vibrating finisher itself and second to the modification and extension of mechanical operations indicated desirable with dry mixes. It is to be noted that in all the experimentation reviewed the equipment engineer has worked closely with the road engineer and has altered equipment design and structure as joint experience developed the desirability of modification.

With the articles of the first group, published in the last preceding issue, the articles that follow constitute the most complete summary yet published of research in concrete pavement construction by vibration.

Finishing Unaffected in Ohio

Added strength secured by vibration without delay in finishing and no increased difficulty in handling

By R. R. Litehiser and C. W. Allen

Chief Engineer and Assistant Engineer, Respectively, Bureau of Tests, Ohio Department of Highways, Columbus, Ohio

THE FIRST EXPERIENCE in Ohio with a vibratory finisher was in 1931, with an early type of machine. By 1933 a number of improvements had been made in the vibratory finisher, and in the light of the earlier favorable experience it was given another trial. This was done on a concrete pavement 1½ miles west of Crestline, in Crawford County. A short section of the concrete pavement had been finished with the ordinary type of finisher of the same model as the one on which the vibrators were mounted. This made it possible to compare the vibrated concrete with that placed under usual job conditions.

The regular mix was 6.3 sacks of cement, with a slump not greater than 2½ in. Crushed limestone and limestone sand were the aggregates. These were batched at the aggregate plant about 20 miles from the job, which made the usual corrections for moisture content in the interest of uniform concrete exceedingly difficult.

The vibratory finisher had two screeds. Three unbalanced ¼-hp. motors were mounted on the front screed equally spaced, and two similar motors on the rear screed at the third points. The front screed was 18 in. wide, with a bull nose built on a 2¼-in. radius. The rear screed was 12 in. wide. The motors on each screed could be operated separately or together at speeds varying from 3,600 to 4,000 r.p.m.

The vibratory finisher was placed on the forms ahead of the ordinary finisher and operated alternately with and without the vibrators. After the trial the vibratory finisher was removed and the remainder of the job was completed with the ordinary finisher. In general, during the trial the finisher with the vibrators off and the regular mix were used for the first two hours of the day, followed by eight hours with the vibrators working with various mixes, and then the remaining two hours with the finisher with the vibrators off and the regular mix. In this fashion comparison could be made of concrete placed the same day under two different methods of finishing. Thus 7,204 sq.yd. were finished with the ordinary finisher, 5,091 sq.yd. with the vibratory finisher with the vibrators working, and 2,113 sq.yd. with the vibratory finisher operating without the vibrators.

Results of tests

The laboratory had three representatives on the job, and a careful record was kept of the work. In order that a comparison might be made of the con-

TABLE I—DESIGN OF CONCRETE MIXES EMPLOYED IN PAVEMENT VIBRATION TESTS BY OHIO HIGHWAY DEPARTMENT

Mix. No	MIX			Quantities in Cubic Feet Absolute Volume Per Cubic Yard of Concrete						Per Cent of Average of Regular Mix Poured Same Day and Finished Regular	
						Water Used		Aggregate		Age in Days	
	Nominal	As Used Dry Loose	b/b_o	Per Cent Sand	Cement	Calc. Water	Min.	Max.	Fine	Coarse	7 Days	28 Days
Regular	1-5½	1-2.34-3.42	.78	40	3.15	4.12	3.92	5.05	8.39	11.34	100	100
Special No. 1	1-5½	1-2.18-3.62	.81	38	3.15	4.15	4.15	4.15	7.87	11.83	No regular mix poured	No regular Mix poured
Special No. 2	1-5½	1-2.13-3.70	.83	37	3.15	4.15	4.15	4.23	7.62	12.08	"	"
Special No. 3	1-5½	1-2.08-3.76	.85	36	3.15	4.03	4.04	4.30	7.42	12.40	132	122
Special No. 4	1-5½	1-2.02-3.86	.87	34	3.15	3.90	3.78	4.24	7.24	12.71	124	...
Special No. 5	1-5½	1-1.98-3.94	.89	33	3.15	3.78	3.78	4.07	7.11	12.96	122	119
Special No. 6	1-5½	1-1.82-3.94	.89	31	3.15	4.34	4.02	4.86	6.55	12.96	111	112
Special No. 7	1-6½	1-2.37-4.51	.89	34	2.75	3.75	3.69	3.93	7.52	12.98	88	94

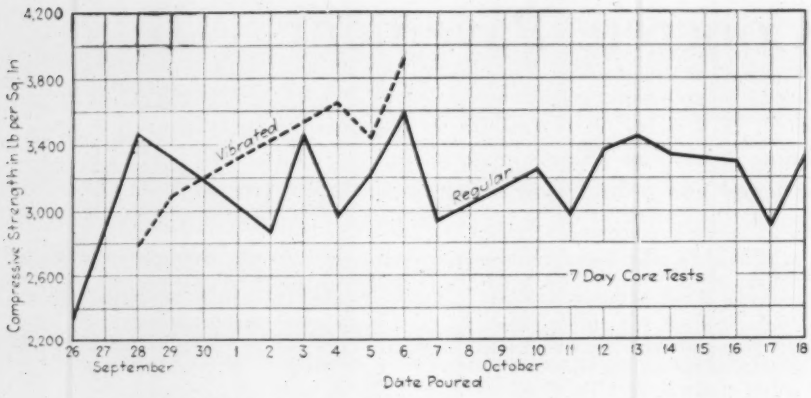


FIG. 1—AVERAGE 7-DAY compressive strength for each day of vibrated and non-vibrated concrete.

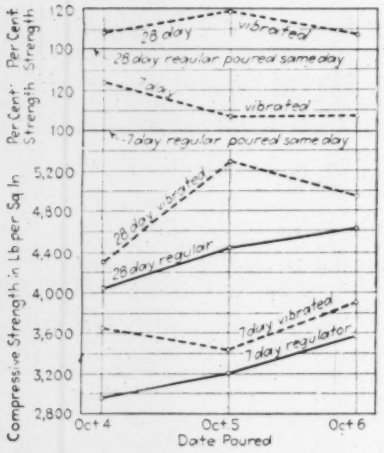


FIG. 2—AVERAGE 7- and 28-day compressive strength of vibrated and non-vibrated concrete for three successive days.

crete on a strength basis, cores were cut at 7 and 28 days from both the regular and the vibrated mixes and tested in the laboratory the same day. The results of the tests can best be explained by tables and charts that are presented in the following order:

Fig. 1 is a chronological strength chart showing the average 7-day compressive strength each day during the job of both the regular and vibrated concrete. It will be noted that the day the trial began there was a decided improvement in the regular concrete, which in general carried throughout the job. Although the vibrator was operated on Sept. 28, the regular mix was used, which proved exceedingly sloppy with the vibrator. On Sept. 29 two special mixes were used, but interrupted operation did not permit placing any of the regular mix without vibration for comparison. The vibrator was not used again until Oct. 4; beginning with that date it will be noted that the strength of the vibrated concrete is always well above that of the regular concrete for the same day.

Table I gives the mixes used, the quantities in cubic feet absolute volume per cubic yard of concrete, and the percentage relation between the vibrated and regular concrete each day, when tested at 7 and 28 days. Table II compares the 7- and 28-day average strengths of the regular and vibrated mixes with our average strengths for the same mixes and same coarse aggregate during 1933. It will be noted that the regular mixes on this job were well above the average.

Fig. 2 shows the average 7- and 2[illegible]-day compressive strength of the regul[illegible] and vibrated concrete placed on Oct. 5 and 6, on which the principal co[illegible]parative tests were run. It will [illegible] noted that the average strength of t[illegible] vibrated concrete is always well abo[illegible] that of the regular concrete. The pe[illegible]centage relation is shown at the top [illegible] the chart.

Fig. 3 shows the percentage streng[illegible] relation at 7 days between the regul[illegible] and vibrated concrete, where the pe[illegible]cent of sand in the special vibrat[illegible] mixes is also shown. It will be not[illegible] that the most favorable results for t[illegible] vibrated concrete were with 36 per ce[illegible] of sand.

Fig. 4 shows the average 7-d[illegible] strength of vibrated concrete with c[illegible]ment factors of 6.3 and 5.5 respectivel[illegible] By plotting the average 7-day streng[illegible] of the regular concrete on the sa[illegible] chart it appears that this same 7-da[illegible] strength might have been obtained wit[illegible] a cement factor of approximately 5.[illegible] had the concrete been vibrated. Our experience in this respect seems to ha[illegible] been more conservative than that of th[illegible] other states with their vibrated co[illegible]crete, although it checks closely wit[illegible] the experience of the U. S. Bureau of Public Roads. It indicates another way of capitalizing on vibration.

Summarizing, the vibrated concrete

FIG. 3—PERCENTAGE STRENGTH RELATION between vibrated and non-vibrated concrete for mixes with various amounts of sand.

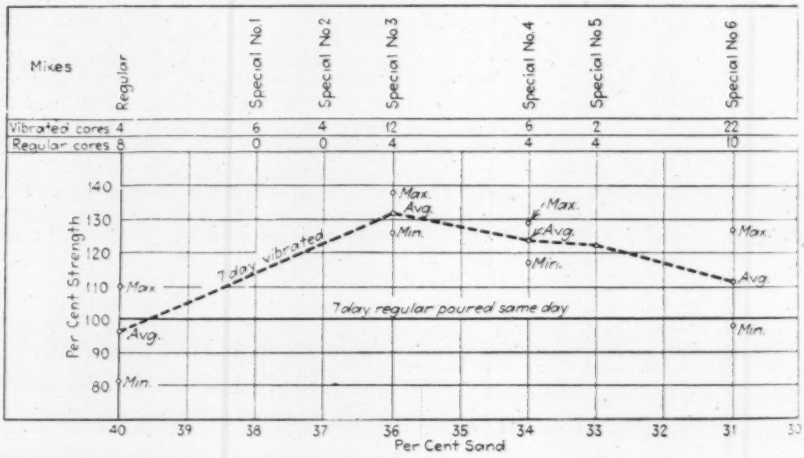


TABLE II — STRENGTH TEST RESULTS OF VIBRATED AND NON-VIBRATED PAVEMENT CONCRETE

Nominal	Age in Days	Method of Finishing	No. of Tests	Average Strength, Lb. Per Sq.In.	Total No. Tests for 1933 — Same Mix Coarse Aggregate and Computed Age (Finished Regular)	Computed Average Strength, Lb. Per Sq.In. for 1933 — Same Mix Coarse Aggregate and Computed Age (Finished Regular)	Per Cent of Average For 1933
1-5½	7	Regular	42	3,191	285	2,610	122
1-5½	7	Vibrated	52	3,617	285	2,610	138
1-5½	28	Regular	12	4,214	285	3,900	108
1-5½	28	Vibrated	17	4,780	285	3,900	123
1-6½	7	Vibrated	4	2,813	None	.....	...
1-4½	28	Vibrated	2	4,185	None	.....	...

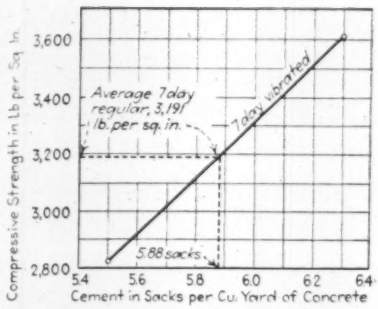


FIG. 4—STRENGTH of vibrated concrete with cement factors of 6.3 and 5.5.

on the trial job was on an average 13 per cent stronger, as judged from the compressive strength of cores cut from the pavement, than the regular concrete, on a job on which the compressive strength of the concrete was approximately 22 per cent above the average of all other jobs of the same coarse aggregate for the same mix for the same year.

It should be mentioned also that the increase in strength, although unsupported by actual measurement in this study, is undoubtedly due to the ability of the vibrator to place and finish concrete much drier than was possible with the ordinary finisher. On one occasion during the trial, while the finisher was being used without the vibrators, the regular mix came out so dry that the finisher was stalled. However, when the vibrators were turned on the concrete was handled with ease.

To compare the effect of the vibrator with the usual spading that is done along the forms, one vibrated section was placed without spading. When the forms were removed there was no honeycomb. In this respect the vibrator performed more satisfactorily than hand spading, which is, of course, dependent on the thoroughness of the spader's work.

Occasion was taken to talk frequently with the hand finishers and the men putting in the premolded expansion and center joints, in order to get their opinion of how the vibrated concrete affected their work. These men had no complaint to make. The vibrated concrete was no harder to work than the regular concrete.

It should be mentioned, however, that the men behind the mixer found the drier concrete harder to handle than the regular mix, although they had less handling to do when the vibrator was working. The score seemed about even here.

This discussion has been confined largely to the additional strength in concrete which accompanies the use of the vibratory finisher. A study of the effect of the vibratory finisher on the density of concrete is under way at the laboratory at the present time but has not progressed to the point where results can be discussed.

Illinois Finds Some Scaling

Reduction of water content ½ gal. per bag is possible with vibration

By V. L. Glover

Engineer of Materials, Illinois Division of Highways, Springfield, Ill.

AN EXPERIMENTAL pavement about 1 mile long and consisting of 114 individual sections was constructed. Gravel was used for coarse aggregate in about half the sections, and crushed stone in the remainder. With a few exceptions each section was placed with a different mixture.

The machine was the standard-type finishing machine except that the screeds were heavier and wider and were equipped with electrically driven vibrator units operating at 3,600 impulses per minute. Four vibrators were mounted on the front screed and two on the rear. In addition, the front screed was designed to aid in placing the concrete in the most favorable position for vibration. The screeds were operated in the usual manner, vibration being imparted while the screed was in motion.

Design of mixtures

The mixtures were designed to determine the limiting quantities of coarse aggregate that could be used with mortars of varying consistencies and to determine the mixtures best suited for the equipment. The possibility of reducing the amount of mixing water was also studied. The mixtures regularly used with the standard finishing machine were used as the basis for comparison.

The general scheme was to vary the constituents of the mixtures as much as possible and still keep them workable. Three general types of mixtures were used, those in which the quantity of water was the only variable, those in which the sand was the major variable and those in which the coarse aggregate was the only variable. With the exception of those in which the amount of mixing water was the only variable, all mixtures were designed for a given strength, regardless of consistency.

The approximate limits of the ingredients of the mixtures were as follows: cement, 1.10 to 1.60 bbl. per cu.yd. of concrete; ratio of fine aggregate to total quantity of aggregates, 30 to 40 per cent; slump, 0 to 3 in.

Test routine

The aggregates were tested and the batch weights corrected in accordance with established practice. Slump tests were made to aid in the study of consistency. The operations of placing, compacting and finishing were studied closely and detailed records kept. Four 6x12-in. cylinders and two 6x6x3-in. beams were made from each experimental section. Small mortar cylinders were made on several sections to determine the quality of the mortar as deposited and after being worked to the surface. The 6x12-in. cylinders were molded in paraffined cardboard containers, filled and vibrated on the front screed from 20 to 30 sec. The 6x6-in. beams were molded in steel forms, filled and vibrated for the same length of time with special apparatus applied to the surface of the concrete and to the form. The 2x4-in. cylinders were cast in brass molds, using mortar screened through a No. 4 sieve.

When the concrete had hardened sufficiently, five cores were drilled from each section to obtain representative samples. Two were taken at points where the batches overlapped when they were deposited on the subgrade so that this condition would be represented. The other three were taken at representative points within the section. The beams and large cylinders were cured in damp sand at the site of the work; the small cylinders were cured in water. The beams and cylinders were tested at the age of 14 days, and the cores at an average age of 74 days.

Results observed

Shortly after opening to traffic, the surface of some of the sections exhibited signs of scaling, whereas the adjacent pavement built with the standard finishing machine showed no evidence of this defect. The mixtures that were most suited to the vibratory equipment did not exhibit this tendency to any great extent, and it appears likely that the excessive working of the harsher mixtures during the placing and finishing caused or contributed to the occurrence of the scaling. It is logical to assume that if all mixtures had been workable and plastic, little or no scaling would have occurred. The scaling is not progressing after a period of 1½ years, and

this defect cannot, therefore, be termed serious.

Dense concrete was obtained throughout. The ability of the vibratory finishing machines to handle and consolidate the mixtures was remarkable. The cores show no more frequent or pronounced honeycomb than is found in concrete placed in the regular manner. The mixtures most suitable for the equipment had a slump of ½ in., a ratio of fine aggregate to total aggregate of 32 per cent for gravel mixtures and 35 per cent for crushed-stone mixtures, and a cement content of 1.25 to 1.30 bbl. of cement per cu.yd. of concrete. The cement content was about 15 per cent less than that of the standard mixtures, or a reduction of 1 bag per cu.yd. of concrete.

No particular reduction in the design strength was noted except where excess water was necessary to place the harsher mixtures. Tests of the mortar cylinders did not indicate a reduction in the strength of the surface mortar from overworking. It appeared that the water content of the standard mixture could be reduced nearly ½ gal. per bag of cement, which should result in a substantial increase in the strength of concrete without increasing the cost appreciably.

New Jersey Requires Vibration

Advantages of vibration proved by several years of practical use in a variety of structures

By R. B. Gage
New Jersey State Highway Department
Trenton, N. J.

THE CONSOLIDATION of concrete by vibration has been employed by the New Jersey state highway department for several years. It was first applied to the fabrication of concrete pipe about 1928. The results then secured demonstrated what might be accomplished in the manipulation of concrete in other types of construction; it was then used experimentally in foundations, abutments, walls, bridge slabs and concrete piles, where its use is now required.

There is no longer any question regarding the improvement that can be secured in the proper placing of concrete, the embedding of reinforcement and density of the concrete by the vibratory method. The porosity adjacent to forms and reinforcement has been eliminated, and surface grouting and hand finishing have nearly disappeared. The benefits secured can be fairly definitely determined, for the concrete generally is exposed on several sides, or sections can be cut therefrom for examination. The behavior of the concrete used in piles constructed by this method also indicates what has been accomplished. To date, we do not have any record of the failure of a single concrete pile constructed by vibration.

Vibration of pavement

The first use by the highway department of the vibratory method to consolidate concrete used in pavement construction was about 1931. Since that time numerous changes have been made in the methods of application of the vibrating impulses. The defects inherent in certain types of equipment previously used have been corrected as far as possible.

The proper consolidation of the concrete used in pavements is not as easily accomplished as that used in structures. The vibrating impulses in the former case are applied only to a single surface of the concrete and from there are transmitted to the adjacent concrete. Most of the excess mixing water that has not been absorbed by the subgrade is usually brought to the surface, consequently such concrete will stiffen much quicker and be more difficult to consolidate than that used in structures. It is, therefore, quite important that the concrete used in pavements be placed in a single layer and consolidated as quickly as possible after placing, to secure the maximum density and uniformity. When the concrete is placed in two layers, the bottom layer is frequently installed 15 min. or more before being covered with the top layer or consolidated, and has then hardened so that proper consolidation is seldom secured.

It appears to be advantageous to have the vibrating element rest directly upon the concrete and not come in contact with the side forms either before or during consolidation of the concrete. In order to insure proper consolidation for the full depth of the concrete, the vibrating element should have ample unimpaired vertical movement and should be so constructed that its entire weight will be constantly applied to the concrete even when the bottom surface of the vibrator is functioning at least 1 in. below the grade of the pavement surface, otherwise the compression required for proper consolidation may be limited to the top layer of the concrete.

Again, in order to avoid supersaturation of the top layer of the concrete with any excess mixing water excluded, the bottom surface of the vibrating element should be so shaped as to permit easy and quick egress of air, forcing any excess of mixing water to the surface of the concrete. If this excess air and water cannot escape, it will be absorbed and retained in the surface layer of concrete and produce a porous mortar that will accelerate peeling and disintegration.

Results of vibration

In judging the results secured by the vibratory method of consolidating the concrete used in pavement construction

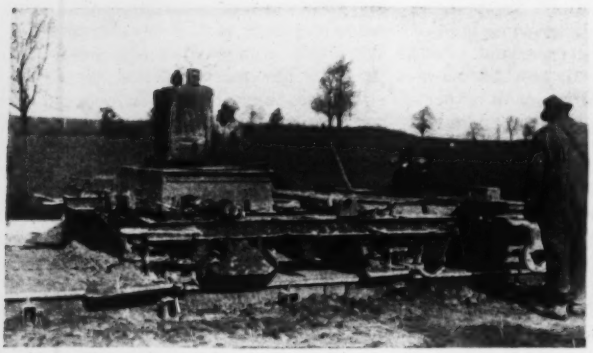


FIG. 5—TWO TYPES of vibratory finishing machines that have been used in New Jersey.

FIG. 6—VIBRATING CONCRETE PAVEMENT with vibrator mounted on a hand-operated screed.

in New Jersey, the fact must not be overlooked that such concrete contains only the minimum quantity of fine aggregate needed for proper density and finishing and that such concrete is more difficult to consolidate properly than when finer aggregate is used; yet by this method the desired density has easily been secured. However, it has been found rather difficult to consolidate mixtures by hand, unless workability is secured by the use of excess mixing water, which lowers both the density and strength of the concrete.

The vibratory method of consolidating concrete makes possible the use of the maximum quantity of coarse aggregate without sacrificing strength, density, plasticity or workability. As a general result, all of these factors are improved. An increase of 10 per cent in the compressive strength of the concrete is not uncommon. As the coarse aggregate is increased, a corresponding decrease in the cement content per cubic yard takes place. When the consistency of the concrete is maintained within foolproof limits, the excess coarse aggregate appears to aid in the manipulations necessary for the proper finishing of the concrete.

The compressive strengths secured on cores taken from pavements and slabs constructed by the vibratory method were higher than those taken from unvibrated concrete. Cylinders cast at the same time gave similar results. The compressive strength also was increased by the addition of more coarse aggregate.

Merits of vibratory method

The benefits to be derived by the use of the vibratory method to consolidate concrete are not limited to an increase in strength and density, for other construction factors are advantageously affected. However, it should not be assumed that the use of the vibratory method of consolidation will eliminate or always correct the damage that may be caused by the use of excess mixing water, abbreviated mixing periods or improperly proportioned or graded aggregates. It is safe to assume that the use of the vibratory method in pavement construction, when properly applied, will not lower the density or strength of the concrete and may prove advantageous in the following manner:

1. In distinguishing the presence of excess mixing water.

2. In determining the real consistency of the concrete.

3. Since it is more difficult to operate a vibrator properly on thin sloppy concrete than when it is of the proper consistency, the average quantity of mixing water being used will gradually be reduced.

4. The cement content per cu.yd. of concrete can be reduced without sacrificing strength or density.

5. The porosity in the concrete adjacent to joints will be greatly reduced or eliminated; the methods now employed are of little value for this purpose.

6. The porosity in the lower half of the pavement will also be reduced or eliminated. Hand tamping or screeding does not eliminate such porosity.

7. The excess surface mortar is reduced to a minimum.

8. The greatest density is produced where most needed in the pavement—that is, in the surface layer.

9. The coarse aggregate per 7-bag batch of concrete can be increased from 125 to 200 lb. without diminishing the

TABLE III — COMPRESSIVE STRENGTH OF 28-DAY CORES TAKEN FROM CONCRETE PAVEMENTS CONSTRUCTED BY THE VIBRATORY METHOD

Name	Vibrator	Proportion Dry Loose Volume	Sand	Coarse Aggregate	Average Compressive Strength At 28 Days, Lb. Per Sq In.
Collingswood Road, Monmouth County, Township and Borough.	Baily-Davis Roller	1-1.53-3.5	Silica	Trap Rock and Gravel	5,305
Haddonfield-Berlin Rd., Camden County.....	Baily-Davis Roller	1-1.56-3.5	Silica	Gravel	5,536
Park Ave., Merchantville, Camden County, Township and Borough.	Baily-Davis Roller	1-1.56-3.5	Silica	Gravel	5,016
River Road, Camden County.....	Baily-Davis Roller	1-1.40-3.5 (Central Mix)	Glacial	Gravel	5,291
West Englewood Ave., Bergen County, Township and Borough.	Blaw-Knox	1-1.75-3.5	Silica	Trap Rock	4,599
Woodside Ave., Newton, Sussex County, Township and Borough.	Baily-Davis Roller	1-1.53-3.5	Glacial	Limestone	5,252
Struyk Ave. & No. 11th St., Prospect Park Borough, Passaic County, Township and Borough.	Baily-Davis Roller	1-1.75-3.5	Glacial	Trap Rock	5,016 not vibrated 5,864 vibrated
Route 29, Section 12A, Centerville-River Road.....	Baily-Davis Roller	1-1.52-3.5	Glacial	Gravel	5,109 not vibrated 5,740 vibrated

Cement per cu. yard — 6.7 bags.
Vibrating element rested only on and supported by the concrete — not on forms.

TABLE IV—COMPARATIVE COMPRESSIVE STRENGTHS AT 28 DAYS OF VIBRATED AND UNVIBRATED CONCRETE CYLINDERS AND CONCRETE CORES CUT FROM VIBRATED AND UNVIBRATED SLABS

Date Made	Cylinders Paper Molds		Cylinders Iron Molds		Cores		Slump, In.
	Vibrated	Not Vibrated	Vibrated	Not Vibrated	Vibrated	Not Vibrated	
7-17-33.....	6,011	5,864	....	....	4,672	4,313	1½
"	6,138	6,084	....	....	4,658	4,492	"
"	6,575	5,860	....	....	4,930	4,733	"
Aver.....	6,241	5,936	....	....	4,753	4,513	
7-18-33.....	6,225	5,507	6,267	5,696	4,915	4,374	1½
"	5,722	4,929	6,472	5,664	4,795	4,552	"
"	5,795	5,004	6,296	5,510	4,488	4,492	"
Aver.....	5,914	5,147	6,345	5,623	4,733	4,473	
7-19-33.....	5,414	5,218	5,844	5,131	4,373	4,313	1½
"	5,504	5,077	5,556	5,557	4,856	3,665	"
"	5,652	5,365	5,593	5,491	4,343	4,210	"
Aver.....	5,523	5,220	5,664	5,393	4,524	4,063	
7-20-33.....	5,716	5,365	6,194	5,105	4,435	4,488	1½
"	5,719	5,291	6,079	5,418	4,597	4,150	"
"	5,919	5,434	5,782	5,552	4,913	4,331	"
Aver.....	5,785	5,363	6,018	5,358	4,648	4,323	
7-24-33.....	5,520	4,859	5,878	5,488	4,611	4,153	1½
"	5,651	5,146	5,770	5,277	3,771	4,057	"
"	5,576	5,247	5,701	5,463	4,313	4,190	"
Aver.....	5,582	5,084	5,783	5,409	4,232	4,133	
Grand Aver.....	5,809	5,350	5,953	5,446	4,578	4,301	

The cylinders and cores cast on any given date were all made from a given batch of concrete, used in the fabrication of concrete piles.

Proportion by dry loose volume, 1 cement—1.66 silica sand—3.0 trap rock.

workability or plasticity of the concrete.

10. The cement content per cu.yd. of concrete can be decreased by ¼ to ½ bag without lowering the strength of the concrete or density of the mortar.

11. Considerably stiffer concrete may be used than can be economically handled and consolidated by other methods.

12. The final surface finish can be given considerably sooner than when the concrete is not vibrated. A greater yardage per day of pavement can thus be placed and finished during daylight working hours.

The accompanying tables show the compressive strength secured on 6-in. cores taken from concrete pavements constructed by the vibratory method, the vibrating element being supported only on the concrete. The concrete in these pavements was found to be dense and quite uniform. The mortar in this concrete had a strong, dense, glassy appearance and was free from evidence of the use of excess mixing water. To date, no defects have appeared in this concrete, such as peeling, scaling or other evidence to indicate that the concrete in any way has been injured or its life impaired by the vibratory method.

If the average quantity of mixing water now being used is reduced by the vibratory method, it is safe to assume that both the average density and strength of the concrete will be increased thereby, with very little, if any, added cost. Since the cement used per cu.yd. of concrete can also be decreased without lowering the strength of the concrete, the cost of the concrete per unit will be reduced accordingly. These two factors alone make the use of the vibratory method both advantageous and desirable in pavement construction.

Equipment for Vibrated Pavements

Greatest economy of production requires a plant designed for construction by vibration

By Lion Gardiner
Vice-President, Jaeger Machine Co., Columbus, Ohio

WITH THE APPLICATION of vibratory finishing to concrete pavement, a distinction has to be made between equipment that may be used for short stretches and odd parts and that required for straightway concrete roadbuilding for long distances where fast and economic production are essential. Stated differently, hand templets vibrated in various ways, can be used for widening, intersection corners and other odd slabs; but if vibration is to be a general paving operation, a far more highly developed equipment unit is called for. Specifically, a vibratory finishing machine is demanded that will take the place now occupied, in the paving-plant train of machines, by the ordinary finishing machine, and will in no greater degree curtail speed or plant coordination. This requirement is believed to be fundamental if vibration is to develop wide usefulness in concrete paving.

Supplementary equipment

Another factor to be taken into account is that while the vibratory finishing machine, in replacing the ordinary finishing machine, does not in general alter plant plan and processes, it does introduce some new conditions. Loading, batching and subgrading equipment and processes require no change. But with the vibratory process, a drier, harsher and less workable concrete is introduced; the machine itself is heavier and develops vibratory impact. These differences call for some modifications in collateral processes and equipment.

With a vibratory finisher normally no less than an 8-in. base form is desirable, and additional emphasis has to be put on good form setting. A majority of state specifications calls for 8-in. base forms as regular practice, so that the vibratory finisher introduces no unusual practice.

In form-setting the primary requirement is solid tamping. To secure this, attention is being directed to machine tamping. One state specifies its use. A tamping machine is now available which rides a line of forms and tamps the soil underneath the base and crowds extra material into soft spots and voids. Machine tamping has proved a decided improvement over hand tamping in reducing the settlement and maintaining the alignment of the forms.

The economic theory of vibration is the ability that it gives to use a concrete ranging from ½- to 1-in. slump. This less flowable concrete may require some change in current paving-drum design. The use of the standard paving mixer with these dry mixtures may increase the time of discharge 2 or 3 sec. per batch. Any change required in paver-drum design can, the manufacturers advise, be readily taken care of. Truck mixers are available which will mix and discharge the dry mixture as quickly and efficiently as they now handle standard 1-in. to 2-in. slump concrete.

The main difficulty introduced by the harsher mixture is that it is harder to spread. Where the spreading is by hand, one or two more puddlers are required, depending upon the rate of production. This indicates the adoption of machine spreading as an adjunct to vibratory finishing. Machine spreaders are now in use designed to spread one 10-ft. lane width of concrete as it is dumped by boom and bucket. These spreaders are being designed for spreading two lanes 20 ft. wide. They are arranged to strike off the concrete at one level for placing reinforcement and again at the level of the top of the pavement. Experience has demonstrated that with machine spreaders ½- to 1-in. slump concrete can be spread effectively for vibration at the required production speed and within permissible cost limits.

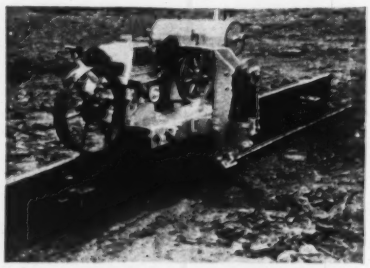


FIG. 7—MECHANICAL TAMPER that rides form rail and tamps subgrade soil under the base.

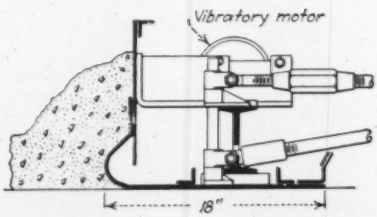


FIG. 8—SKETCH of bull-nose front screed for vibratory finishing machine.

Vibratory finisher

Obviously, the vital tool is the vibratory finisher, which must compact and densify the harsh mixture and leave it with a surface smoothness that will take a final finish with no greater effort than is required for mixtures of standard consistency. To condense description and discussion, analysis of design principles and machine construction will be based on a make of machine developed after four years' experimentation in the shop and in actual paving operations.

Dealing with a machine that, in addition to the stresses of normal screeding action in a stiff concrete, is subjected to 3,600 to 4,000 imposed vibrations a minute on the screeds, it is apparent that a strengthened screed construction is necessary. A broader screed face is also essential to bring up the mortar required for a good finish and to drive the aggregate into tight interlock for density. In the finisher selected as an example all screed adjusting bolts and motor connections are of steel, heat-treated to insure high tensile strength and toughness. The front screed is 18 in. wide, or 6 in. wider than in the non-vibratory finisher, and the rear screed is 12 in. wide. The front screed is also of different form, its front edge being turned up to form a "bull nose" of about 2½-in. radius, as shown by the accompanying drawing.

Experience has shown that with a dry concrete some means is advisable for riding the screed edge onto the windrow of concrete pushed ahead of the screed and drawing it under the screed face for compaction. This action is particularly important in the first, or strike-off, pass of the finisher, which otherwise requires the front of the screed to be raised or canted up to bring ample concrete for good compaction under the screed. Raising the screed for the first pass throws a heavier load onto the front wheels of the finishing machine and consequently greater load concentration on the forms.

The vibratory element may be either electrical or mechanical. In the finisher being discussed the vibrating units are electric motors with unbalanced weights. In the 20-ft. finisher three motors are mounted on the front screed and two on the rear screed. These are operated by a small separate motor generator mounted on the frame of the finisher.

Operating results

In some of the experimental work a mix design of such harshness—i.e., a high rock content with low water-cement ratio—was used as to be impracticable for final edging of the joints and yet was thoroughly compacted under the finisher. With proper screed setting and proper mix design, the hand finishers back of the machine have reported no additional difficulty beyond that encountered on the average job, although it has been noted that with the use of the drier mix the work of edging joints must be kept closer to the finishing operations so that the slab may be more promptly covered with wet burlap.

The additional cost to the contractor for owning and operating vibratory finishing machines may vary from ½ to 1c. per sq.yd., depending upon daily production and methods used; and although there may be a slight increase in the bids for this work, nevertheless the possibility of a cement saving ranging from 5 to 10c. per sq.yd., depending upon design of mix and cost of cement, readily offsets the additional expense.

Cracked Culvert Interlined With Corrugated Pipe

Circular corrugated pipe welded outside, pulled into culvert, centered and grouted in place through pipes from the surface

By V. O. Powell
U. S. Engineer Office, Rock Island, Ill.

DAMAGE by settlement of a concrete culvert passing through a Mississippi River levee at Helena, Ark., developed interesting practices in restoring the structure to full service. Incidentally, the failure indicated need of supplementary design considerations in similar culvert work where foundation-soil conditions normally presage settlement.

The culvert was constructed by the local levee board in 1931, and is a modified horseshoe section on wood piles (Fig. 1). It was designed to support only transverse loads (loads on linear-foot increments of barrel), and lacked sufficient resistance to bending of the barrel as a beam. The wood piles did not support the culvert as planned, but sank with the region of earth under the levee base in which they were driven. The unequal settlement and sag of the culvert set up enormous bending and shear stresses against which there was negligible resistance.

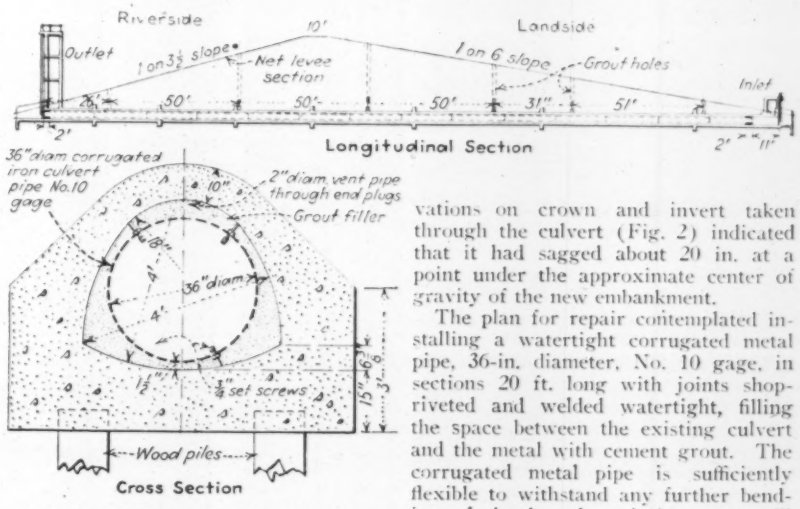


FIG. 1—PROFILE AND CULVERT SECTION, showing interlining and method of placing grout through pipes from surface.

Failure and repairs

Shortly after the new earth levee was partly up to gross section over the new culvert, transverse breaks were discovered in the barrel; and when the land-side gate was closed against a rising river and pumping into the culvert began, several large leaks were noticed near the land-side toe of the new levee. These leaks became so serious that a derrick boat and diver were used to install the river-side gate under water on the anchor bolts provided in the concrete, and the front of the culvert was sandbagged to insure against a blow-out and crevasse at this point. When the river receded, the culvert was inspected in March, 1932, and sixteen complete clean traverse breaks were found in the barrel. A profile with elevations on crown and invert taken through the culvert (Fig. 2) indicated that it had sagged about 20 in. at a point under the approximate center of gravity of the new embankment.

The plan for repair contemplated installing a watertight corrugated metal pipe, 36-in. diameter, No. 10 gage, in sections 20 ft. long with joints shop-riveted and welded watertight, filling the space between the existing culvert and the metal with cement grout. The corrugated metal pipe is sufficiently flexible to withstand any further bending of the barrel, and the grout will serve as a rigid filler. The grout was to be placed through holes extending through the earth levee and the crown of the concrete culvert, and the culvert pipe was to be installed by inserting sections at the river-side end and alternately welding a section and pulling the pipe into culvert.

Detailed procedure

Holes were bored through the levee to the concrete culvert with an 8-in. auger, and 7-in.-diameter stove pipe, bradded together at joints, was inserted in the hole. The corresponding points inside the culvert were then located and holes were cut through the crown of the culvert with an air jackhammer. Six such holes were bored at approximately equal intervals along the barrel. It was necessary to complete the holes and

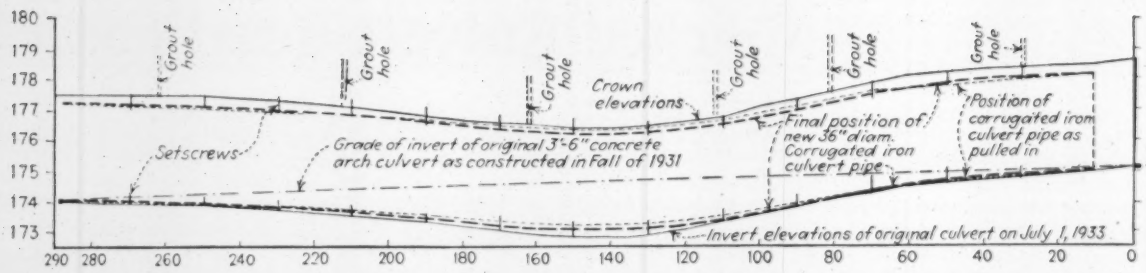

Grout hole
Crown elevations
Setscrews
Grade of invert of original 3'-6" concrete arch culvert as constructed in Fall of 1931
Final position of new 36" diam. Corrugated iron culvert pipe
Position of corrugated iron culvert pipe as pulled in
Invert elevations of original culvert on July 1, 1933
180
179
178
177
176
175
174
173
290 280 260 240 220 200 180 160 140 120 100 80 60 40 20 0

FIG. 2—SETTLEMENT of culvert and position of new corrugated-pipe interlining.

clean out the debris before the work of installing the pipe could be begun.

The culvert pipe was delivered by truck and unloaded on the crown of the levee, from which position it was rolled down the river-side slope by a snatch rope. The river-side end of the culvert was then unwatered and heavy timbers were placed across the ditch to support the pipe for installation. A section of pipe was rolled into place, inserted in the culvert and pulled in a sufficient distance to place the joint over the welder's platform.

The hoist line was attached to the front end of the leader section of pipe by welding four strips of $\frac{3}{8}$-in. steel plates 24 in. long to the inside of the pipe. Sheared holes in the ends of the plates permitted connecting a line to the main cable at a point 8 ft. in front of the pipe. The main cable consisted of a $\frac{1}{2}$-in. galvanized-wire cable run through a snatch block at a point 8 ft. in front of the pipe, one end of the line being tied to a timber placed across the land-side end of culvert and the other tied to a 6-to-1 block line ($1\frac{1}{4}$-in. manila rope) at the hoist. Hemp rope proved unsatisfactory for the main cable because it stretched and jerked the pipe. The ratio of pull on the drum of the hoist to the force required to move the pipe was 1 to 12. A 10-hp. gasoline hoist worked satisfactorily without overloading. The pull increased greatly with the length of pipe in the barrel, but no difficulty was encountered on account of the sag in the barrel. The pipe was forced to deflect and did so without injury to the metal or to the welded joints.

Joints were made by using a 12-in. band of the same 10-gage metal and drawing the band up tight by means of a jack and chain. Then places were progressively spot-welded and tightened until the band was drawn up to a snug fit, with the corrugations of the band corresponding to those on the pipe. The complete weld was then made. A single bead weld on each edge of the band was considered sufficient. On account of fitting the corrugations of the pipe sections to the band, a space about 1 in. wide was left between sections of pipe. This space was stuffed with mastic cement so that water and air could not get between the pipe and band from the inside.

After the entire length of pipe was drawn into the culvert, it was necessary to place the culvert pipe in its final vertical position. This was provided for before the pipe was pulled into the culvert by welding four $3\frac{1}{4}$-in.-diameter square nuts on the bands at suitable positions around the joints and then burning a hole through the metal pipe for a $\frac{3}{4}$-in.-diameter set screw to be inserted from the inside of the pipe. When the pipe was pulled into final horizontal position, the set screws were inserted and the pipe shifted to its final vertical position.

After the pipe was put in final position, the spaces between the metal and culvert at the ends for a distance of 2 ft. were securely plugged with broken concrete and cement mortar. A piece of 2-in. water pipe was placed through the plug at the top to serve as a vent for air and surplus water. These plugs were placed three days before grouting operations were begun.

The concrete mixer and all aggregates and cement were placed on the crown of the existing levee and all grout mixed from this position. The cement grout consisted of 1 part cement to 2 parts sand (by volume, loose) with $4\frac{1}{2}$ gal. of mixing water added per cubic foot of cement. This produced a strong and workable mortar that readily flowed. The pouring began in the first hole, just land side of the levee crown. This hole took about four-tenths of the total grout poured before grout appeared and remained at the top of the hole. Grout was then conveyed through a wooden chute to each hole in succession, completing the river-side pouring first, until filled. As each hole filled, soundings were made in the next hole, and grout was found to be over the top of the metal pipe in each case. Water flowed as though under pressure through the vent pipes in the end plugs when the last holes were being filled. When grout began to flow through the vent, it was plugged tight. Grouting was continuous until entirely completed. The absolute volume of the grout poured checked the computed space between the metal pipe and the concrete, which is reasonably positive assurance that the space was entirely and effectively grouted.

The culvert is believed to be very effectively and practically repaired. The original culvert was amply designed to resist transverse loading (and is now even stronger in this respect). The metal pipe makes the culvert absolutely watertight, and the culvert is further strengthened by the cement-grout ring. The cost of the work was:

278 lin.ft. 36-in. corrug. copper molybdenum pipe No. 10 gage, @$6.15 f.o.b. the job	$1,709.70
Installing and welding pipe.....	761.22
33 cu.yd. cement grout @ $19.36	638.89
Total cost of work	$3,105.89

The work was performed by U. S. government hired labor under the direction of Major W. M. Hoge, Corps of Engineers, District Engineer, U. S. Engineer Office, Memphis, Tenn., with H. V. Pittman as area engineer at Helena, Ark.

Mosquito-Control Methods to Be Used at TVA Reservoirs

MOSQUITO-CONTROL methods similar to those used when Wilson Lake was formed at Muscle Shoals will be applied to both Norris Dam and Joe Wheeler Dam reservoirs immediately on completion of those two projects, it has been stated by W. G. Stromquist, sanitary engineer for the Tennessee Valley Authority. The most effective of these, since the lakes will be primarily power reservoirs, will be through the operation of the power-generating plants at the dams. The drawdown of the water for the generating of power will come at the season when millions of the mosquitoes are in the larvæ stage and floating on the surface along the shores of the lake. The release of the water at the dam will lower the reservoir and strand the mosquito larvæ on the shore, where lack of moisture and the heat of the sun will eliminate them as a health menace. The lowering of the reservoir may leave pools of still water cut off from the main body of the lake. If these cannot be ditched so as to drain thoroughly when the lake is lowered, they will be treated either with oil or with some chemical, such as paris green. The third means of control will be the stocking of the reservoirs with the small surface minnow, which feeds to a considerable extent on mosquito larvæ.

River Water Used at Dresden to Increase Ground Supply

Water from Elbe River is settled and filtered and then allowed to seep into the ground—Biological process of manganese removal used

By C. Martin Riedel
Designing Engineer, Bureau of Engineering, Chicago, Ill.

DURING a recent visit to Germany the writer had the opportunity of seeing part of the water-supply system of the city of Dresden. There are a number of features of the treatment plants of more than ordinary interest to the sanitary engineer. These are worthy of description.

Dresden, situated on the Elbe River, is a city of about 620,000 population. It possesses a municipally owned water-supply system, including purification works that render a water of exceptional quality. Since about 1873 the water supply has been taken from wells driven along the banks of the Elbe River. Today's daily consumption is about 90,000 cu.m., or 38.2 gal. per capita.

Almost all the water drawn from the gallery of wells is river water. All suspended heavy organic matter is removed by mechanical straining on its way through the soil and sand between the riverbed and the well points. But the river water contains some manganese, and in addition there are soluble manganese compounds in the soil, so that the water after collection contains up to 1.5 p.p.m. of manganese, which must be removed before the water is potable.

Special demanganization plants have been built, which also help materially to prevent the growth of algæ in the city piping system. Decarbonation plants, based on the lime-treatment scheme, have also been added to all waterworks, since the free oxygen of the water together with the free carbonic acid causes destruction of the pipes. With the help of lime a protective coating forms on the walls of the pipes, aiding against corrosion.

After siphoning, the water is collected from the long row of shallow tubular wells by a suction pipe leading to a suction well. A saturated lime solution prepared in huge funnel-like tanks is added here to combine with the carbonic acid in the water. The water is then pumped into 10-ft.-diameter pressure tanks for demanganization. These tanks hold two layers of coarse quartz sand, the voids of which are filled with a dense growth of manganese algæ. The characteristic ability of these algæ to consume and store manganese is utilized to rid the water of this troublesome element. Removal is quite satisfactory. Gradually all voids in the filter bed are filled with manganese algæ, only demanganized water emerging. From time to time the filters are rewashed and cleaned of the accumulated manganese sludge. This operation and the special tanks have been patented by the designing division of the city waterworks department of Dresden.

In order to cope with the ever-increasing demand of water, the capacity of the suburban Hosterwitz plant has been considerably increased in capacity by adding a "groundwater enrichment" plant. Raw water is taken out of the Elbe River at two intakes and pumped into open settling basins having concrete walls and a concrete bottom. The water remains here at least four hours, settling out from 30 to 60 per cent of the suspended matter. From here the preliminary settled water is pumped to closed rapid-sand filters, where the remaining suspended matter is removed. The effluent is turned back to the groundwater in open-air infiltration basins (sprinkling filters) where aeration takes place, so that certain tastes and odors of the river water are removed.

There is an 8-in. layer of sand on the bottom of these infiltration basins. After a certain length of service manganese algæ grow on this sand bed and have to be removed. This is done by scraping off about 1 to 2 in. of the surface of the sand layer and loading it into small cars on an industrial track leading to a washing plant, where it is thoroughly cleaned.

Around the group of infiltration basins, at a distance of about 200 ft. from the outer walls, there is a row of tubular wells from which the water from the groundwater basin is drawn through long suction lines into the main suction well near the filter plant. From the main suction well the water is pumped to the lime and demanganiza-

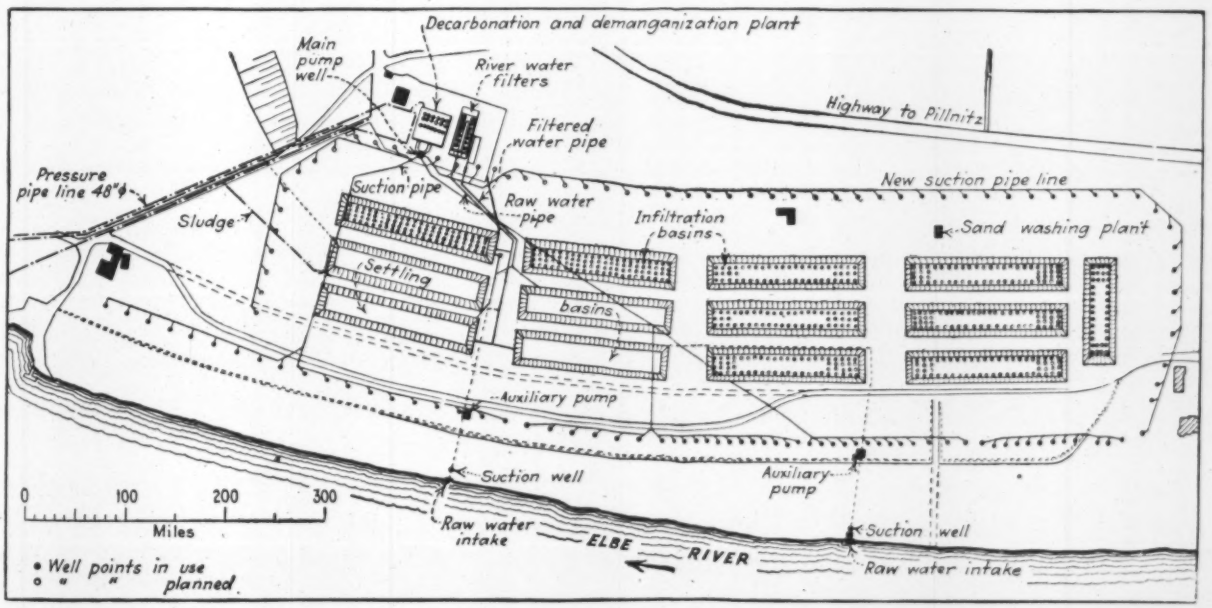


FIG. 1—DRESDEN'S water supply for many years has been taken from a long row of tubular wells driven along the bank of the Elbe River. The capacity of the plant at Hosterwitz has been increased by "enriching" the groundwater. Water from the Elbe is settled, filtered and then sent to infiltration basins, where it is aerated and allowed to seep into the water-bearing soil.

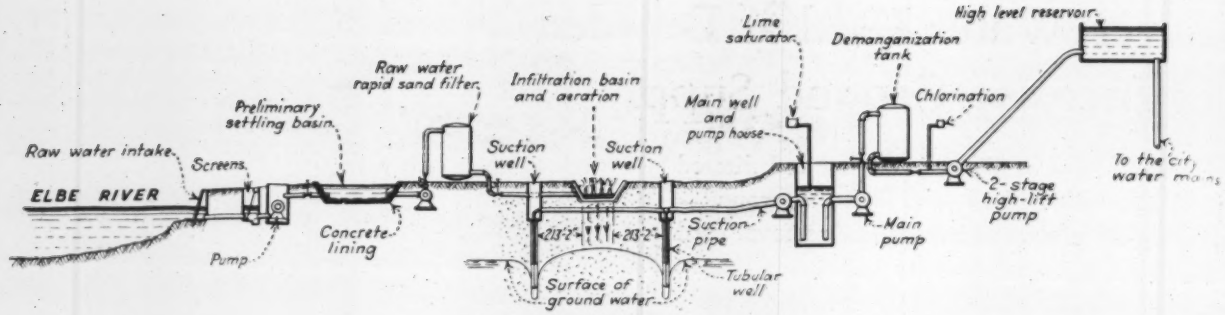


FIG. 2—DIAGRAMMATIC cross-section through the Dresden water plant at Hosterwitz. The water obtained from the wells is treated with lime to remove the free carbon dioxide. Manganese is removed by pressure filters in which manganese algæ thrive.

tion treatment tanks, as described before.

The treated water is finally pumped in two stages into large reservoirs on nearby heights, about 180 ft. above the level of the river. From here the mains of the city are served.

The power sources for pumping in all Dresden works are electrical and are interconnected to provide for emergencies. One of the three water-purification plants has also a generating plant consisting of a generator driven by a 450-hp. diesel engine. This furnishes power sufficient to operate the main gates, auxiliary pumps and furnishes lighting. The power plant is built to function in case of failure of the city power plant and may be put in operation in 3 min.

The writer desires to acknowledge his indebtedness to the director of the Dresden waterworks, Dr. Vollmar, and Stadtbaurat Dr. L. Wahl for their assistance in gathering the data that are given in this article.

Halifax Pier Shed Quickly Rebuilt to Meet Winter Service Demands

Upper floor of reinforced-concrete structure, completely wrecked by fire in late September, cleared of debris, rebuilt and restored for heavy winter traffic through the port of Halifax

FIRE of unknown origin on Sept. 19, 1933, completely wrecked the upper floor of the shed on Pier No. 2 in the port of Halifax, Nova Scotia. As Halifax is a winter port, going into active service when navigation closes on the St. Lawrence River in late November, loss of this important unit of the port was a serious handicap and called for urgent work in getting it back into service.

Pier No. 2 is entirely of concrete construction, and the pier shed was of reinforced concrete, 200x608 ft. in plan and two stories high. The upper floor was a 6-in. concrete slab with a 1½-in. finish carried on concrete beams and heavy girders of 40-ft. span. The roof also was a concrete slab with a built-up surface, supported on concrete columns, girders and beams; the central bay carried a monitor 5-ft. high.

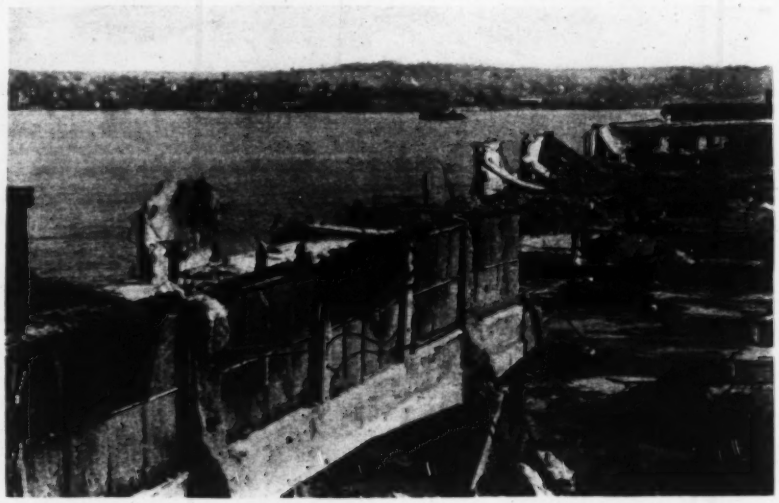
During the fire the entire contents of the upper floor were destroyed, and the entire roof, including beams, girders, columns and side walls, collapsed progressively with the exception of a few bays at the inner and outer ends. It was a week after the fire before the building was cool enough to inspect, and even then the cargo was still smoldering.

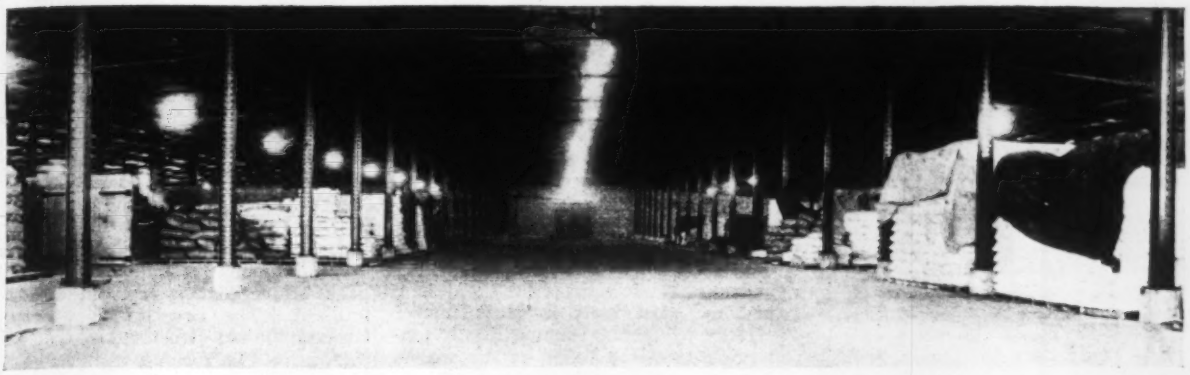
As a result of the fire in the upper floor, the whole pier was thrown out of action, storm water running through the construction joints and openings in the upper floor to such an extent that it was impossible to use the lower floor as a transit shed.

Immediately the structure was cool enough to start work, a contract was let for the removal of the debris and old concrete and the surfacing of the upper-floor slab. The first work to be carried out under this contract was to clear enough of the slab at various locations to permit cutting out specimens for testing, to determine the extent to which the slab had been damaged. Though some specimens indicated a certain amount of loss of strength, the slab was found generally to be fit for use, and only a few bays had to be cut out and replaced.

Because of the early approach of winter weather and the time element involved, it was decided to rebuild the superstructure using a structural-steel frame with corrugated siding and steel sash, a brick facade at the inner end and a brick firewall at the midpoint. A mill-type roof with a tar and gravel covering was specified. Since half of the shed is required for heated storage, hollow-tile lining was specified for the inner end of the shed, set back 6 in. from the cor-

THE UPPER FLOOR of the shed on Pier No. 2 at Halifax, Nova Scotia, a reinforced-concrete structure, was completely wrecked on Sept. 19 last by fire.





STEEL COLUMNS and roof trusses replace the reinforced-concrete frame in the reconstruction of the upper floor of the shed on Pier No. 2. This picture shows the unheated section.

rugated sheathing to provide an air space. The roof also was insulated. At the extreme inner end a suite of offices was provided to replace those destroyed.

Preliminary plans for this work and estimates of cost were prepared within a few days after the fire and submitted to the Department of Marine at Ottawa, so that the money necessary for the work could be provided promptly. Subsequently preparation of detail plans was begun. In the examination of the structure for this work it was found that because of the large amount of reinforcing steel at the column points on the upper floor, it would be impracticable to drill for anchor bolts for the new steel columns and, consequently, the dowel rods of the old concrete columns were bent over and concrete pedestals about 1 ft. 6 in. high were poured around them, the anchor bolts being set in these pedestals. This work was done by the demolition contractor.

Detail plans were ready and bids called by Oct. 11 when the government made money for the structure available. The order to start steel erection was telegraphed from Ottawa, and the whole frame was erected and riveted seven weeks later.

As the upper floor was cleared of debris and the old surfacing an asphalt floor was laid over the entire 3-acre area in eight days, despite adverse weather conditions. In carrying out this work the asphalt trucks and a 10-ton roller were taken to the upper floor on a temporary ramp, and during the laying of the asphalt the 10-ton roller was run over the entire floor area, thus demonstrating its soundness. Openings in the floor were curbed and temporarily covered over, and as the asphalt surface made it watertight the lower floor was put into use again during the first week in November.

Plans for other elements of the work were ready in time to let a contract on Oct. 28, and by Dec. 16 the outer half of the upper floor was put into use despite the fact that steel erection was not complete until the first week in November. Severe weather interfered with this work and with the roof construction, but by the middle part of January the inner end of the upper floor—the section that is insulated and heated—was put into use. It was found necessary to build a temporary housing around the brick facade at the west end because of severe weather conditions.

Contracts for the repair and replacement of six electric escalators, the installation of an entirely new elevator, and for lighting and heating fixtures were let as soon as the plans were ready.

Although the lower floor was practically uninjured, a great deal of damage was done to the structure below the upper-floor level. The concrete end walls were badly cracked and spalled, and the inclosures around the stair wells were completely wrecked. All spalled concrete was replaced, and the stair wells were repaired with gunite. The original sliding cargo doors on the lower floor, already in poor condition at the time of the fire, were so badly damaged by falling concrete as to require complete renewal. They were replaced by filling in the alternate panels with tile and the installation of new doors in the remaining openings. A sprinkler system was installed throughout the upper floor and offices.

The temporary ramp built to facilitate paving work on the upper floor was found so useful that a permanent ramp was installed to give trucks direct access to the upper floor.

The entire reconstruction work was practically completed by the middle of January of this year, three months after the start of actual work.

The reconstruction work was carried out by the Halifax harbor commissioner, for whom E. H. James, Montreal, acted as consulting engineer during reconstruction. The principal contractors were the McDonald Construction Co. for the demolition work and for the principal building work except the steel frame, which was erected by the Robb Engineering Works. Paving was done by the Standard Paving Co. Separate contracts were let for mechanical and electrical equipment as the drawings were made ready for bids.

RECONSTRUCTED SHED of Pier No. 2 at Halifax. The entire upper floor, originally of reinforced concrete, was replaced with steel-framed construction during the early part of the past winter following its destruction by fire.

Rock Island Roller Gates —A Correction

Fabrication of the roller-gate drums and fabrication and erection of the service bridge and bulkheads for the roller-gate dam at Rock Island, Ill., described in *Engineering News-Record*, March 29, 1934, p. 410, were carried out by the American Bridge Co. as subcontractors respectively to the S. Morgan Smith Co. and S. A. Healy, general contractor.

County Highway Bridge Uses New Type Timber Trusses

Laminated make-up of timber members alternating with board sheathing provides a truss of unique design

By C. P. Martin
Dayton, Ohio

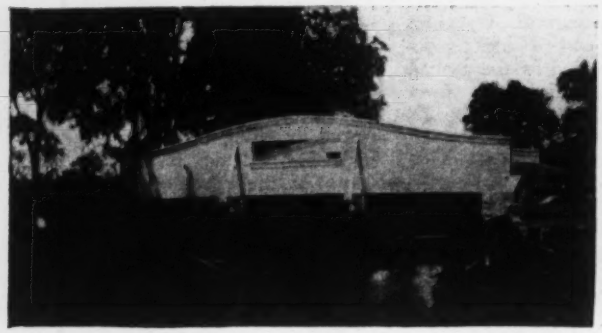
A NEW TYPE of truss has recently been utilized in a 40-ft.-span timber bridge over Turtle Creek on a county highway about 3 miles north of Sidney, Ohio. Designated by its originators, H. L. and C. F. Loudenback, of Sidney, as a "compound multi-ply truss," the new design is made up of alternate layers of sheathing and timber-truss assemblies glued, nailed and bolted into a single solid unit. Unusual strength and rigidity are claimed for the design, and the span itself is given further rigidity by special framing details connecting the floor beams to the trusses and by a deck of double diagonal subflooring. An additional advantage of such a truss is that its capacity may readily be increased while the bridge is in service merely by adding layers of truss members and sheathing.

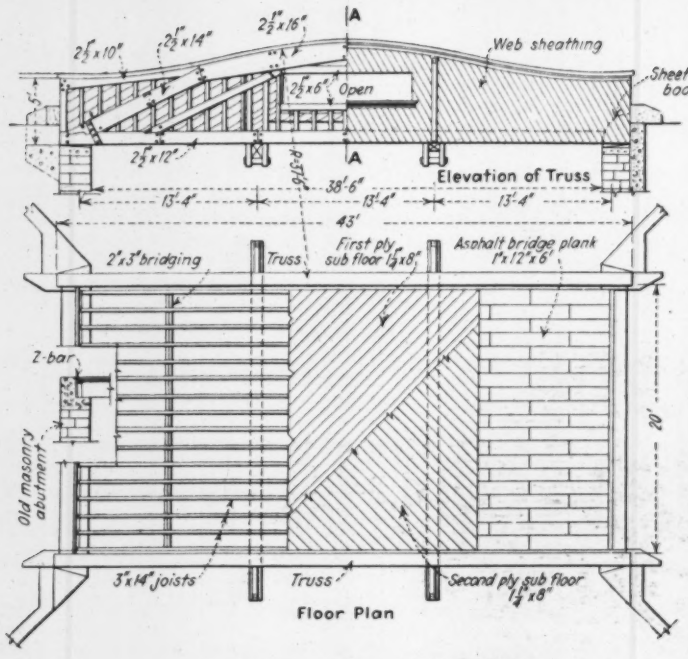
Details of the Turtle Creek Bridge are shown in the accompanying drawing. It has a 22-ft. roadway and was designed to be capable of supporting a 30-ton load with a safety factor of four. A test conducted with a 26-ton load of trucks and other equipment showed no measurable sag in relation to a chalk line stretched between the abutments.

The bridge was built in 31 days. Inasmuch as it weighed only 76,630 lb. total, the masonry abutments of the old iron bridge that it replaced could be utilized. The new bridge was built around the old structure, so that traffic was held up for only eight hours.

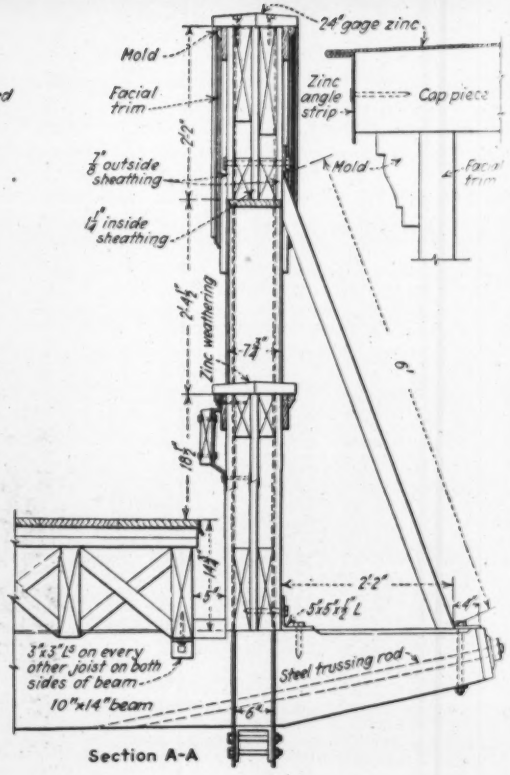
The truss members of the bridge are thoroughly guarded against the elements. A weather-proof cap of 24-gage zinc covers the tops of the trusses; a casein waterproof glue is used in the joints between the sheathing and the trussing; the ends of the trusses are encased in lead shields; and all lumber used is treated chemically, to be insect-resistant and fire-retardant.

TWO VIEWS of timber bridge utilizing compound multi-ply type trusses. Span is 40 ft. The roadway, 22 ft. wide, is surfaced with asphalt plank.





STRUCTURAL MAKE-UP of timber bridge utilzing compound multi-ply trusses. Each truss consists of two assemblies of truss members and three layers of sheathing applied diagonally.



Three-Point Road Roller Smooths Surface Waves

Bituminous resurfacing operations in Georgia and Texas demonstrate usefulness of three-rolls-in-tandem road roller in reducing surface waves

NOTEWORTHY smoothness has been secured on some recent bituminous-road resurfacing operations in Georgia and in Texas by rolling with a three-rolls-in-tandem roller. The Georgia operation was on U. S. Route 41 in Lowndes County and was the resurfacing of an existing bituminous concrete pavement 20 ft. wide with a ½- to 1-in. emulsified asphalt mixture. The Texas operation was on the Dallas-Fort Worth state road No. 1 and consisted of widening a concrete road and resurfacing the old concrete with hot-mix asphalt. Both operations have features of interest in addition to the unusual roller equipment.

Resurfacing black base in Georgia

The outstanding feature of the work in Lowndes County was the use of the three-rolls-in-tandem roller to eliminate waves produced by ordinary roller equipment. The construction was undertaken as follows: A special slag graduated from 1½ in. was distributed over the existing base at the rate of 100 lb. per sq.yd.; 2-in. planks about 8 in. wide, laid flat along the edges of the pavement, served as forms to prevent the slag from spreading. After spreading the stone for 800 to 1,000 ft., a distributor sprayed the aggregate with ½ gal. of a slow-break emulsified asphalt. This was followed by mixing with a retread machine, one-half the width of the road being covered while going in one direction and the remaining half while returning.

Again the distributor passed over the mixture, spraying ½ gal. a sq.yd., making a total of 1 gal. per sq.yd. This was followed immediately by a second mixing with the retread machine, which was immediately followed by a blade grader. Upon completion of the blading, the entire surface was rolled by a 12-ton three-wheel roller in the regular manner, starting at the edges and rolling toward the center, lapping half the rear roll on each trip over. After the entire width had been thus covered at least once, slag screenings graded from ¼ in. were uniformly distributed over the surface at the rate of 12 lb. per sq. yd., from an improvised container attached to the dump trucks.

This produced a surface more or less wavy, a condition which the highway department was seeking to avoid. At this point the rolling was immediately resumed, but this time the divison maintenance crew used a three-roll-in-tandem roller. To make the process clear, it should be explained that this roller differs from an ordinary three-wheeled roller in having an additional wheel or roll in the center. This wheel is hydraulically controlled, can be raised or lowered at will or set in a perfect plane with the front and rear rolls of the roller. It also can be removed entirely if desired. The action of three wheels rotating in the same exact plane necessarily establishes a plane. Should any irregularity of surface be encountered, the wheel contacting it would bear down with fully 85 per cent of the weight of the machine and flatten it out.

On the Georgia job the center wheel was lowered until it ocupied a position about ¼ in. above a plane with the front and rear rolls. The entire width of the road was then rolled to eliminate the larger waves. The center wheel then was set in its normal or plane position with the front and rear wheels, and the entire surface was rolled again.

A perfectly smooth surface resulted; no irregularities could be found, although the work was checked daily with a surface inspector adjusted to detect errors of ⅛ in. in 10 ft. Gas and fuel consumption and other operating costs were about the same as in ordinary practice, and a superior road surface was obtained with less rolling.

For the most part, the smoothing action of the center wheel was accomplished without difficulty. The normal amount of voids in this particular mixture was such that it accepted, with few exceptions, sufficient compaction within itself to permit the forming of a plane. In a few instances areas were encountered where an excess of material had been spread. In such cases the middle roller, after compacting the material to refusal, would push the excess aggregate before it, making it necessary to remove this excess before a plane could be established. The rolling action in all other respects was entirely similar to the ordinary methods of rolling.

The resurfacing crew worked under the immediate direction of D. B. Thompson, division maintenance superintendent, acting under H. H. Johnson, bituminous engineer for the Georgia state highway department.

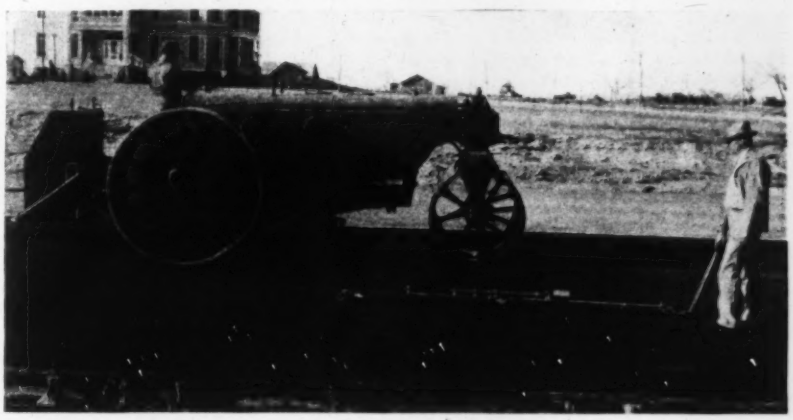
Resurfacing concrete in Texas

The resurfacing of the 34-mile Dallas-Fort Worth road was done under the direction of W. H. Courson, general superintendent, and Harry Beman, surface foreman. Mr. Davis, bituminous engineer, Clifton Rice, division engineer, and C. L. Wibford, resident engineer, represented the state. The contractor was the Central Bitulithic Co., of Dallas, Tex.

The existing concrete, which for various reasons had become prohibitively rough, was widened with concrete to a width of 40 ft. The widened portion of each side was finished slightly higher than the old concrete to permit a course of asphalt binder to be laid flush with the new concrete, thereby bringing the entire area of the 40-ft. width to a uniform surface while correcting the irregularities in the surface of the original road.

Along the center line of this 40-ft. highway thus prepared, a 2-in. steel-channel side form was fastened. Along the outer edge of the pavement, the side forms which originally had served as forms for the widened concrete were raised 2 in. above the finished surface and blocked up into place. From the forms thus established a standard fin-

ROAD ROLLER with three rolls in tandem and 10-ft. recording straight-edge used on bituminous resurfacing operations in Georgia and Texas.



ishing machine struck off a modified Topeka hot mix, delivered on the pavement surface from canvas-covered dump trucks at a temperature of 375 deg. F. This course consists of a uniformly graded mixture of coarse aggregate, fine aggregate, mineral filler and bituminous material proportioned by weight.

As soon as 100 lin.ft. or so of this mixture had been spread and struck off by the finishing machine, the course was immediately compacted with two 8-ton tandem rollers. Upon this compacted surface, about 1½ in. thick, a second or non-skid wearing course was laid. This mixture was likewise struck off by a second finishing machine, and the surface was immediately rolled with a 12-ton three-wheeled roller and a 10-ton three-rolls-in-tandem roller, followed somewhat later by a final rolling with a 10-ton tandem roller.

The same surface test was made as in Georgia, the device being adjusted to detect errors of ⅛ in. in 10 ft. In a distance of nearly 4,000 ft. only four places were found in excess of that limit, and those slight variations were due to imperfections in the base course which was rolled in the ordinary way.

Approximate Design Method for Concrete Skew Rigid Frames

By Edward F. Gifford
Assistant Engineer, New York Central R.R. Co., New York, N. Y.

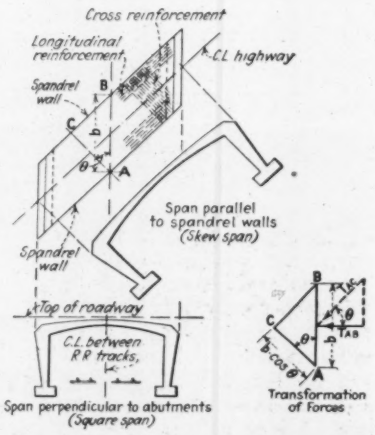
ONE of the most difficult problems confronting the engineer engaged in practical designing is the analysis of the stresses in the ring of a concrete skew arch or rigid frame. Owing to the fact that the forces and moments are not parallel to a single plane, the structure must be analyzed in three dimensions instead of the two used in the design of a right arch.

Several methods have been developed for designing concrete skew arches, the most notable being those of Prof. J. C. Rathbun (College of the City of New York), published in the *Proceedings*, Am.Soc.C.E., February, 1924, and of Bernard Weiner (Westchester County Park Commission), published in the *Proceedings*, Am.Soc.C.E., January, 1931. Richard M. Hodges, assistant engineer, Westchester County Park Commission, has also developed an explanation of the skew-arch theory that is in excellent form for the designer; it is published in Arthur G. Hayden's "Rigid-Frame Bridges."

However, the methods proposed to date require several weeks of intensive mathematical computations, aided by a calculating machine, to determine the moments and thrusts at the various sections throughout the structure. And after completing the computations there remains the determination of the internal stresses. At best, the methods are laborious and time-consuming processes, and this article proposes an approximate method, based on Professor Rathbun's theory, that is believed to be satisfactory for preliminary design in determining a trial section and to give results that will compare favorably with the so-called exact methods.

The method had its beginning in some model tests of reinforced-concrete skew rigid frames conducted by the writer several years ago to determine how this type of structure fails under various loading conditions. In all cases the first cracks appeared at the obtuse corner of the top slab and continued about perpendicular to the face of the bridge. This seemed to indicate that the longitudinal reinforcement, to be most effective, should be placed perpendicular to these cracks or parallel to the spandrel walls. Photographs of these tests were used by Mr. Weiner in his discussion of multiple-skew arches published in the *Proceedings*, Am.Soc.C.E., September, 1931. In this discussion it was stated that "If longitudinal steel in a skew rigid frame is placed parallel to the face of the bridge, no transverse steel is required for skew-arch action." The writer does not quite agree with this statement and believes that a nominal amount of cross-reinforcement must be provided to resist the stresses caused by unsymmetrical loading and to assist in distributing the stress in the longitudinal reinforcement over the full width of the arch.

For computing the elastic properties of a skew bridge, a section of the span perpendicular to the abutments is to be used since under deflection the transverse elements of the top slab remain horizontal and parallel to the abutments. However, it is impracticable to place the longitudinal reinforcement perpendicular to the abutments, and its logical position is parallel to the spandrel walls. It is therefore necessary to transform the moments and thrusts acting on plane AB, parallel to the abutments, to plane AC, perpendicular to the spandrel walls. (See diagram.) These transformed moments and thrusts are then resisted by a section of the arch parallel to the spandrel walls.



A SIMPLE TRANSFORMATION of forces from a plane parallel to the abutments of a skew bridge to one perpendicular to the spandrel walls permits design to be carried out as for a square span.

The following simple relation between the span perpendicular to the abutments and the span parallel to the spandrel walls determines the method of procedure, which is to compute the moments M and the thrusts T for a unit width at various points on the arch axis for the span perpendicular to the abutments and then, multiplying M and T by $\sec^2 \theta$ design the steel in accordance with the usual procedure for a right arch.

In the accompanying illustration, the diagram showing the transformation of forces indicates the trigonometry of the procedure. T_{AB} is the total thrust acting on plane AB, parallel to the abutments. T_{AB}/b is the thrust acting on a unit width of plane AB. Likewise T_{AC} is the total thrust acting on plane AC, perpendicular to the spandrel walls and the longitudinal reinforcement. $T_{AC}/b \cos \theta$ is the thrust acting on a unit width of plane AC.

But $T_{AC} = T_{AB} \sec \theta$

Therefore, the thrust acting on a unit width of plane AC is

$$\frac{T_{AB} \sec \theta}{b \cos \theta} = \frac{T_{AB}}{b} \sec^2 \theta$$

The moment acting on plane AB is transformed to plane AC by a similar procedure.

The following rules, determined from a study of skew-arch bridges that have been designed and built, will give satisfactory results:

1. For skews up to 15 deg., design the same as a right arch, using a section and span parallel to the spandrel walls. Provide a nominal amount of cross-reinforcement for distribution.

2. For skews 15 to 35 deg., design as a right arch or square span and apply transformation formula. Use ¾-in. dia. rods 12 in. c. to c. for cross-reinforcement.

3. For skews 35 to 50 deg., design as a skew bridge, following the explanation by Mr. Hodges and using the method described herein to determine a trial section.

4. For skews over 50 deg., it is advisable to use simple plate-girder spans, the girders to vary in depth if an arch appearance is desired.

Cleveland Analyzes Slum Costs in a Notable Survey

IN THE INTERESTS of ascertaining the cost of operating a slum area, an analysis has recently been completed of a typical section in Cleveland, Ohio. Carefully worked out under the direction of Howard Whipple Green, consultant for the PWA housing division, this analysis provides information that has never previously been available. The work was carried out for the Cleveland Metropolitan Housing Authority as a CWA project.

The area considered had a population in 1930 of 22,326, or 2½ per cent of Cleveland's total population. The tax income in 1932 was $225,000 contrasted to the direct cost to the city, county and board of education of $1,357,000. The community fund also contributed $615,000 to citizens in the district. Thus the total cost to the community—$1,747,000—represents a direct subsidy of $78.78 per capita, or $315 per family of four in the area.

With 2½ per cent of Cleveland's population, this area accounted for 14.4 per cent of the maintenace cost of the fire department and 6½ per cent of the maintenance cost of the police department. The appraised value of the land amounted to $3,168,000, the value of the buildings $4,985,000. The area lost 27 per cent in population between 1920 and 1930, and in the same period the proportion of negro to white population rose from 43 to 67 per cent of the total. It is an area with a large number of deaths from tuberculosis and has a bad record for crime, vice and juvenile delinquency.

COMMUNITY EXPENDITURES IN A SLUM AREA COMPARED WITH TOTAL EXPENDITURES FOR THE SAME SERVICES

Basic Data and Services	Cleveland	The Section	Per Cent in The Section
Population, 1930.	900,429	22,236	2.47
Families, 1930.	221,502	5,244	2.37
Assessed value of property	$1,086,382,570	$8,153,470	.75
Area in acres	45,395	333	.73
Miles of streets	1,030	14	1.35
Fire protection	$2,811,923	$406,159	14.44
Police protection.	$3,947,508	$255,597	6.47
Public school education	$12,000,000	$361,927	3.02
Enrollment	148,501	3,587	2.42
Per-capital cost	$81	$101	
Ash and rubbish collection	$517,000	$11,450	2.21
Per family	$2.33	$2.18	
Garbage collection	$590,884	$13,079	2.21
Per family	$2.67	$2.49	
Street cleaning	$180,000	$2,419	1.34
Per mile of streets	$174.76	$174.78	
Street lighting	$1,532,699	$18,570	1.21
Per mile of streets	$1,488	$1,342	
Sewer maintenance	$140,937	$3,128	2.22
Miles of sewers	1,030	14	1.34
Cost per mile	$137.80	$223.43	
Library	$549,934	$33,000	6.00
Playground	$44,000	$990	2.25
Milk fund	$77,913	$6,499	8.34
Mothers' pensions	$607,341	$26,659	4.39
Neighborhood centers		$50,686	
Public Health work	$575,744	$44,888	7.80
Per capita	$.64	$2.02	
Tuberculosis care.	$1,092,000	$67,704	6.20
Juvenile court		$6,375	
Number of cases		255	
Cost per case		$25.00	
Visiting nurses	$98,006	$3,138	3.20
Maternity hospital	$23,490	$2,390	10.17
Bath houses	$107,000	$22,950	21.45
Red Cross, Assoc. Charities Jewish Social Service Bureau	$6,709,934	$490,836	7.32
Childrens' Bureau	$52,998	$8,310	15.68
County Child Welfare	$628,767	$45,187	7.19
Cleveland Humane Society		$46,292	
Soldiers' and Sailors' Relief		$30,397	
Day Nursery Association	$39,904	$13,807	34.60

Letters to the Editor

Replacing a Bridge Abutment Under Railway Traffic

Sir—The object of this letter is to illustrate one advantage of designing steel bridges with the bottom chord capable of resisting compression.

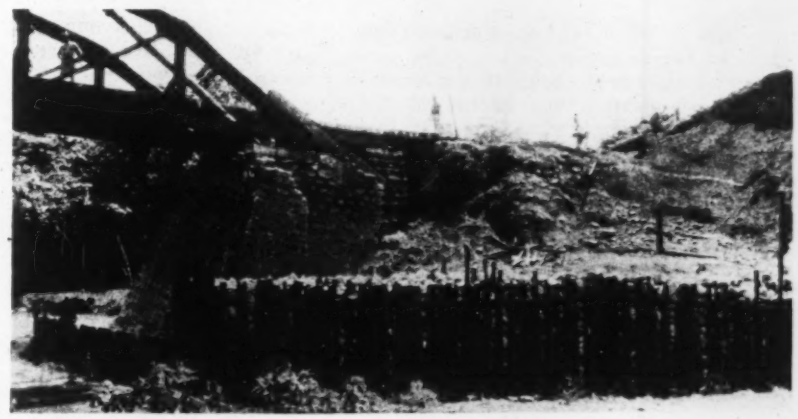
In December of last year a flood undermined the south abutment of Perez bridge, on the Santiago-Puerto Plata Railroad in the Dominican Republic, causing a settlement on the upstream side of about 4 ft. Fortunately, the superstructure, a 100-ft. camel-back truss, was not damaged, due to the rigidity of the steelwork, and traffic was maintained during the next ten months by supporting the track between the sunken abutment and the adjacent embankment on a stone-filled timber crib.

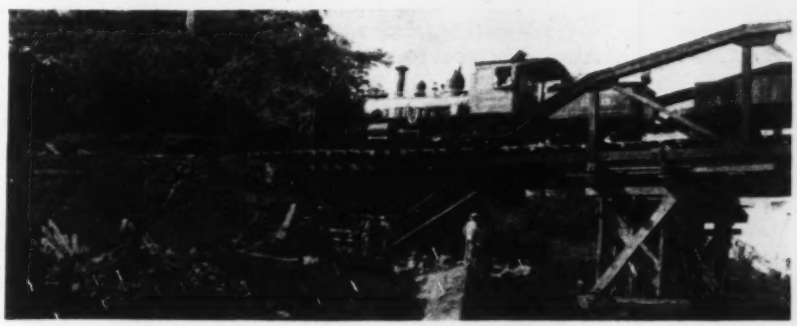
Finally, in October of last year the writer was called upon to build a new abutment without stopping traffic. Fortunately, the steel truss (built by the Pencoyd Bridge & Construction Co., Pencoyd, Pa., in 1894) had a bottom chord of two channels tied with plates. Since this bottom chord was able to take compression, a temporary tower bent was erected beneath the second panel, permitting the first panel to be cantilevered and to serve as a support for one end of a 35-ft.-span queen post truss. This arrangement permitted the old abutment to be removed and a new one built. The queen post truss was made of scrap iron.

RAFAEL BONNELLY,
Engineer and Contractor.

Santiago, R. D.,
Dec. 9, 1933.

BRIDGE ABUTMENT replaced after flood caused severe tilting (above) by supporting bridge on a temporary tower bent, utilizing structural arrangement shown below.





ENGINEERING NEWS-RECORD

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Not So New

WE ARE INCLINED to look upon the streamlining of the new light-weight trains that have been put into service recently as something new, the product of a current demand for the conservation of energy heretofore wasted in overcoming air resistance. It is somewhat of a shock, therefore, to find that more than 40 years ago a patent was issued to one Frederick U. Adams for the design of a streamlined train that, except for the streamlining of the steam locomotive, might have been the model for the new Burlington train described in our news pages this week. The patent was unearthed recently, by the American Locomotive Co. In it a train is shown on which doors and windows are flush with the sides, cars are articulated and the side sheathing is carried down close to the rail and curved back under the car body. This old patent serves to emphasize the saying that there is nothing new under the sun, that most of our progress has not been by sudden change but as the result of a growing consciousness of a special need which generally comes to fruition long after the first ideas of how the need may be met have taken rough form.

Exit the 200-Mesh Sieve

ABSENCE OF REFERENCE to that classic measure of fineness for portland cement—the 200-mesh sieve—in the Boulder Dam specifications and the more recent TVA cement requirements helps to emphasize the passing of this time-honored testing instrument. Modern practice calls for the fineness of cement to be measured in terms of surface area per gram, which is a true expression of fineness, and not by the mere arbitrary rule of the permissible per cent of maximum size of particles. The refinement is roughly comparable to the parallel advance in the technical classification of sand, which was the only means of defining aggregate passing the one-quarter inch screen until the development of the more exact term of fineness-modulus. Similarly, cement need no longer be gaged by the crude scale of the sieve but can be defined in surface area, which is a correct measure of its essential characteristic. Among cement technicians the era of the 200-mesh sieve has already passed, or at least is rapidly passing, and it is important that the engineer become acquainted with the expression "surface area per gram," know its significance and be able to use it intelligently.

A Financial Obligation

AN IMPORTANT SERVICE to construction is being slowed down and may suffer actual curtailment by the indifferent support by contractors of the Bureau of Contract Information. Inspired by the need for an agency to establish verified records of contractors and under the urging of organized contractors, this bureau has built itself to magnificent proportions by the financial support of a single element of the construction industry. Other elements equally served have not contributed. At a time, therefore, when federal and other public contracting agents and independently practicing engineers and architects are making numerous calls for contractors' records, these calls are subject to delayed answers because of the shortage of men and money at the recording and reporting agency. The contracting agent and the contractor desirous of having responsibility established are equally delayed in their negotiations when promptness means business secured and idle men put at work. The responsibility rests squarely on the contractor and materials and equipment producer who has neglected to perform his financial duty. He should speedily remedy his neglect both for the advancement of stability in his industry and for the benefit of his personal business.

Psychologic Safety Factor

CONSIDERATIONS of public peace-of-mind or the effect of massed non-technical opinion occasionally necessitate modification of the strict technical requirements for engineering works. A good example is the present earthfill that has been placed against the downstream face of the Mulholland Dam, as outlined on another page of this issue. Against the preponderance of expert opinion which held that the structure was safe, the continued urgings of the citizens of Hollywood who have the dam constantly in view in Wied Canyon above the city have finally resulted in adding an earth backing to the twenty-year-old concrete structure. Landscaping of the earth slope will complete the psychologic relief, although it is also true that consequences of failure will be minimized. Lay opinion is not based on a consideration of adequate stress-strain relations, and the weight given to uncertainties or vague possibilities often is beyond refuting by cold figures. Situations in which public opinion may prove a factor in engineering design are exceptional; yet unquestionably there are times, particularly in the case of water-storage projects, when such a situation must be considered a factor to be applied after the technical requirements have been satisfied.

Traffic Control Progress

GRADUAL PROGRESS is being made in centralizing traffic control in a state authority. The latest state to take action is Illinois, in which the control authority is the division of highways of the state's Department of Public Works. This body has just issued a statement of policy, summarized on p. 539 of last week's issue, which commands attention in notable particulars. The regulatory power extends to state roads in municipalities and embraces condemnation and removal of existing control devices as well as approval and installation of new devices. Executive power is thus placed back of the announced policy of demanding traffic and accident records as proof of necessity and type of signal control. Here unquestionably is the strong feature of the new state-control policy; it postulates, first, that there must be proof by traffic records that some control device is needed, and second, that the form of this device shall be based on known composition and flow of the traffic streams. The effect will be to eliminate needless signals and to fit needed signals to traffic conditions. Both improvements are much to be desired. More broadly, the new Illinois law marks another step in the uniformity of traffic control for which highway engineers have long fought.

Before the Profession

A REVISED DRAFT of the engineers' code, presumably the final draft, has been completed and has gone forward to the NRA for approval. The outcome of more than eight months of discussion by the code committee, supplemented recently by suggestions invited from other engineers, it expresses well-matured thought on what is possible and desirable in the way of a statute of self-government.

While the NRA will weigh its merits as an economic agency in industrial rehabilitation, the code comes before the engineering community for judgment of its value to the profession. This judgment, which naturally will turn on the extent to which such a code can serve as a restoring and stabilizing force and a corrective of internal difficulties, is in last analysis the more important, for the NRA will vanish but the problems of professional relations will endure.

Two main characteristics mark this document. First, it is a code for the consulting engineer and the so-called engineering constructor exclusively; the main body of the civil engineering profession is left outside. Second, it will do nothing to increase employment or employee income except indirectly through such effect as it may have in improving the employer's business status. Any direct help to the employee must come through the general provisions of Chapter I of the construction code (of which the engineers' code forms a part), which permits area agreements on working hours and wages to be formulated by representative groups of employers and employees. Such groups do not now exist.

Significant features are the omission of fee standards and minimum rates of pay, and the exclusion of engineering work done by contractors and industries. In the matter of fees and pay and in some other respects the code reflects the unfortunate limitations of NRA thinking, which, having been shaped to fit the commodity industries and once having declined to consider professional codes, still appears to be incapable of recognizing the special situation arising where professional activities are involved in a coded industry.

The fair-practice clauses are designed to guard technical responsibility and to set a minimum for technical competence by limiting the delegation of authority in matters involving the principles of engineering only to engineers or to engineering assistants, as defined in the code. The fair-practice provisions should aid in raising the level of the profession's ethics, and it might be wished that they could have a wider influence than is possible under their present restrictions to a small group.

The proposed code is now before the court of professional opinion to decide whether a code is wanted and needed. The document is the best that a hard-working committee could produce through long patient labor, and so expresses what the NRA system can and cannot do for construction engineering. If the code promises to be markedly helpful, the profession owes it support. But also, if its usefulness is small or doubtful, the profession should be ready to express disapproval, for the cost and restriction of code control are justified only if outweighed by substantial benefits.

Whichever way the balance is adjudged to turn, the thoughtful engineer will recognize that through the code a movement of segregation will be introduced into professional life for the first time. Heretofore, employer and employee have been indistinguishable in their technical association; now they are to be set apart into two distinct classes, which in fact, for their required mutual bargaining, must become formally organized into opposing—even though ultimately cooperating—groups.

The cohesion that up to now has marked professional existence will be weakened by this dividing influence. Should the ultimate effect be great enough to divide also the profession's technical interests on the same lines as its economic interests, *Engineering News-Record* believes that the gain to be realized through even the best codes would be dearly bought.

The Winter Paving Problem

RECENT ISSUES have given accounts of a number of winter concrete-paving operations undertaken in furtherance of federal and state activities to relieve unemployment. Notable success has characterized this unusual roadwork; the pavements have been built in cold and often inclement weather and, so far as prejudgment can determine, without detriment to quality. This evidence calls for attention, but economic analysis needs to go beyond provisional conclusions of possibility and quality if winter concrete paving is to become customary procedure instead of occasional practice.

The data for economic analysis are woefully scarce: furthermore the issues are confused by consideration of the social advantage of having highway employment extended throughout the year. Holding to the engineering problem, it can be asserted that if winter work is to become general practice in concrete paving: *first*, specifications and inspection practices in those parts which control details of methods and procedure have to be recast; and, *second*, means of winter construction have to be developed that will maintain output and not increase costs. The second problem is the difficult one. The concrete paving carried on during the past winter has done little to solve it.

The assumption that temperature is the controlling influence in winter roadbuilding is as usual the prevailing error. Whether the work is grading or placing concrete pavement slab, the greatest handicaps are storms and water—specifically snow and rain and the resulting wet ground. Counts of time lost due to rain, snow and wet subgrade and roads by the Bureau of Public Roads show in grading 3 per cent is lost during the normal working season and 19 per cent during off-season work. In concrete paving the losses are much larger, amounting to 5½ per cent and 39 per cent. Concrete paving production is controlled, so far as the elements play any part, by intensity and frequency of precipitation and not by temperature. A pavement slab can be concreted, with very simple precautions, quite as safely in frost as in heat. The past winter's paving work has again proved this fact conclusively.

The major winter problem of the roadbuilder, then, lies in counteracting precipitation and its effects on grade and subgrade; and so far he has made little progress in its solution. Obviously the roadbuilder cannot prevent snow and rain; to build winter roads he must devise methods of diminishing their effects. Possible ways of solution are advance selection of winter projects where soil and drainage conditions are most favorable, pre-preparation or pre-protection of grades, planning haulage routes unaffected by precipitation, and housing the subgrade. In respect to these possibilities past experience gives little help; the field is wide open for the inventiveness of the concrete roadbuilder.

CURRENT NEWS

Construction Code Authority Meets to Elect Appeals Board

THE CONSTRUCTION CODE AUTHORITY meets in Washington, D. C., on May 4, and will elect the nine members of the construction appeals board from nominations made by the sponsors of the code, in addition to considering other important business matters. The appointment of the disinterested chairman of the construction planning and adjustment board is expected soon; the 20 members of the board have already been nominated and accepted by the labor and industry advisory board, and await only the confirmation by the Administrator when the chairman is appointed.

The Administrator has sent a letter to every business establishment indicating that a special Blue Eagle has been prepared and may be obtained by making application directly to NRA. This new insignia is a modification of the Blue Eagle now in use, the word "Code" replacing the former slogan "We do our part" with the designation "Construction Industry" appearing at the bottom.

As heretofore, the Blue Eagle remains the property of the United States, and the right to continue to display it depends upon continued compliance with the code.

A special drive is being made by NRA to approve the divisional chapters which are still pending. The chapters for plumbing contractors, kalamein division, wood flooring, resilient flooring, roofing and sheet metal division and marble contracting are complete from the standpoint of the deputy administrator. Other chapters for building granite, heating, piping and air conditioning contracting division, plastering and lathing, terrazzo and mosaic, insulation contractors and stone setting contractors are almost in final form. The professional engineer's code committee approved what is hoped to be the final draft of the professional engineer's chapter on April 26, and the architect's chapter is similarly nearing completion.

A public hearing will be held on the proposed chapter for the construction news services on May 8. A proposed chapter has been submitted by the bituminous distributors to cover surface treatment work.

Consultant Named for Twin City Sanitary District Project

The trustees of the St. Paul-Minneapolis sanitary district voted, April 16, to employ the firm of Consoer, Townsend, Older & Quinlan, of Chicago, as consultant for the $18,000,000 sewerage project. The consulting fee is reported to be $270,000 as a minimum figure. Subsequent to the naming of the consulting firm, the Minneapolis Taxpayers Association and the Minneapolis Engineers Club protested the selection. On April 27 the contract for the consulting work had not been signed.

State Public Works Bond Issue Rejected by Michigan Voters

Rejection of proposed state bond issue for a state public works construction program by the voters of Michigan at a special election held April 30 prevents the state from fuller participation in the PWA program because of existing laws. The act provided for the creation of a state debt, the issuance of bonds and the borrowing of a sum up to about $38,000,000 from governmental agencies. It was proposed to provide employment for unemployed persons within the state by embarking upon a program of state construction of public works of necessary, useful and state-wide character.

Hearing on First Area Agreement Held under Construction Code

Developments at the first hearing on an area-agreement affecting wages and hours under the construction code held May 1 indicate that the working out of such pacts will mean lengthy local negotiations involving organizations of employers and workers.

The first area-agreement was proposed by the Mason Builders Association of greater New York and certain locals of the Bricklayers, Masons and Plasterers International Union. When the agreement was brought before NRA, on Tuesday, the requests of the unions for immediate approval, without modification, were challenged by independent unions and other employer organizations which questioned the right to put an agreement into effect that would bind them.

Representatives of the Federation of Building Trades Workmen of America and the American Labor Alliance, representing independent bricklayers' unions, asked for more favorable working conditions than the 40-hour week and $1.50 per hour wage proposed.

The Mason Contractors Association of the United States and its New York City branch, the Associated Brick Mason Contractors of Greater New York attacked the right of the Mason Builders Association to negotiate the agreement, on the ground that the latter organization is composed of general contractors and is not exclusively a brickwork contractors group as is claimed. Contractors' organizations from Nassau and Suffolk counties on Long Island protested extending the agreement to cover their localities.

Objection by the general contractors code authority to having such an agreement cover heavy construction or highway work appeared to impress the NRA representatives. This exclusion may also be extended to street railway work.

R. E. Doherty, assistant deputy administrator in charge of the hearing held, however, that the question of the "truly representative" character of the parties requesting the agreement made no particular difference for when the proposed agreement is approved by the President it will not be in the form of an agreement between two parties, but a type of regional code.

Engineers' Code Reconsidered and Again Revised

REVISIONS have been made in the code for the engineering division of the construction industry to incorporate suggestions received following publication of the March 22 draft as well as ideas resulting from informal conferences with NRA officials. The new draft, dated April 26, is not essentially different from the previous one but has some changes in phraseology, minor rearrangements, and there have been paragraphs and provisions added as required by the NRA or executive orders. The new revised draft has again been sent out by the code committee to the local sections of the American Society of Civil Engineers and other interested groups.

The draft of March 22 was abstracted in *ENR* April 5, 1934, p. 452. In the following abstract of the new draft, Article 1, which includes all of the definitions is quoted in full; changes and revisions in the remainder of the draft are abstracted.

ARTICLE I—DEFINITIONS

Section 1. (a) For the purpose of this code the term "Engineering Division of the Construction Industry," hereinafter referred to as the "engineering division" or "this division" and the term "engineering services," shall include the offer to provide, or the providing of, engineering service, in general such as investigation, studies, surveying, planning, design, supervision, inspection, engineering testing, or laboratory analysis for the construction or anticipated construction of any private or public buildings, structures or works, or construction accessory thereto, where such service involves a knowledge of engineering laws, formulae and practice, and a knowledge of the physical properties of the materials of construction and methods of installation, and limited to the following methods of practice or such methods as may be later added by amendment.

(b) "PROFESSIONAL ENGINEERING METHOD" shall include the providing or undertaking to provide and be responsible for any of the engineering services defined in this section, where such services do not include constructor or contractor performance or responsibility. This method may include correlating and supervising construction and installation.

(c) "ENGINEER - CONSTRUCTION METHOD" shall include the providing or undertaking to provide and be responsible for any of the engineering services defined in this section when combined with constructor or contractor performance or responsibility.

(d) The definition in paragraphs (a), (b) and (c) of this section shall not include engineering services necessarily adjunctive to the manufacture, sale, installation or construction of patented de-

(Continued on p. 582)

Triborough Bridge Redesign Work Nearing Completion

SOME time this month, according to present plans, steel erection will begin on the towers and cable bents of the 1,380-ft. suspension span which comprises the East River crossing of the Triborough Bridge at New York. Contract for fabrication and erection of these towers was awarded last fall but delays in meeting eligibility rules for the PWA loan together with delays occasioned by reorganizing the engineering staff of the Triborough Bridge Authority and by redesigning the project so that it could be built within the funds available caused postponement of this work until now. The redesign, being made under the direction of Allston Dana, is now practically complete, and tower plans are being released to the fabricator as fast as they are approved by O. H. Ammann, chief engineer of the Authority and by the PWA engineers.

Instead of two decks and four 20⅜ in. cables, as given in the original design, the East River crossing will consist of a single deck providing two 42-ft. concrete roadways and will have only two 20⅜ in. cables. Two stiffening trusses, 98 ft. center to center, instead of the four originally planned for will be used. The anchorages are already completed for four cables, but the new design utilizes them without essential structural change, merely abandoning the two center groups of cable connections. The finished shape of the anchorage blocks will differ considerably from that first proposed and they will not be faced with granite as contemplated in the original design. Adjacent to the anchorages the first design made provision for concrete arch approach spans; these have been changed to steel plate girders on concrete piers.

The design change that is most obvious occurs in the towers. These were originally four-leg structures with two panels of X-bracing below deck and a portal strut and pointed arches above deck. As redesigned the towers have only two legs, braced below the deck with a parallel-chord truss strut and above deck by two similar struts, one comprising the portal and one tying the tower tops together. The towers are about 300 ft. high above the water in Hell Gate.

Detroit Refunds $280,000,000 Debt with 30-Year Term Bonds

The refunding of $280,000,000 of city bonds and notes of Detroit, Mich., which were to mature during the 10-year period from 1933 to 1943 has been concluded and declared operative by the Detroit Bondholders Committee, New York. Similar action by the city council had been taken previously. This refunding program is considered to be the largest refunding plan in the history of municipal financing.

At the outset it was believed that Congressional action would be necessary to prevent minority bondholders from instituting proceedings against the city which would have forced the treasurer to allot tax money to meet original bond maturities, but nine months of work on the part of the committee and city officials resulted in the depositing of 92½ per cent of the bonds and notes which was considered sufficient to put the plan in effect. City officials estimate that from 97 to 98 per cent of the bonds affected by the plan will be on deposit shortly. The remaining bondholders can legally protest the plan but officials are confident, according to reports, that the courts would rule against them under present conditions.

The funding of this debt with 30-year term bonds maturing in 1963 will make possible the reduction of debt charges during the next five years and city officials are hopeful that the result will bring substantial relief to taxpayers.

Hearings Continue on La Follette Public Works Bill

FURTHER TESTIMONY backing the $10,000,000,000 public works bill sponsored by Senator La Follette has been introduced in Senate sub-committee hearings held on this proposed legislation. Hearty endorsement of the bill was given by civic officials of large mid-western municipalities during the last week.

Arthur W. Brandt, Association of State Highway Officials, pointed out the continuing need for highway construction, and stated that at least $2,000,000,000 could be placed under contract without difficulty on projects of "highest merit." He pointed out that in the past entirely too much emphasis had been placed on the amount of employment afforded directly at the site of the work, and that the employment produced in the manufacturing of materials and equipment and transportation had not been sufficiently stressed. According to Edward Fishwick, national committee, American Water Works Association, the survey made by the association showed that $1,200,000,000 of waterworks and sewerage projects were needed throughout the country. He stated that the present PWA financing will take care of about $200,000,000 of this estimated work.

George T Walbridge, representative of Governor Comstock of Michigan, told the committee that at the present time 23 per cent of the population of Michigan is on direct relief rolls, and declared that this situation is representative of the rest of the country. He contended that public works construction is the only means of providing normal jobs for the unemployed, and stated that there is $289,000,000 of construction work in the state, which is vitally needed at present.

Malcolm Pirnie, former NRA deputy administrator, and president of the American Water Works Association, asked for a continuing PWA program to be authorized at once. Mr. Pirnie could see no private construction possibilities before 1937, because of the present lack of incentive. He held that a public works program of about $3,000,000,000 a year for the next three years was justified to permit industry to take the long view requested by President Roosevelt, and stated that such a program would permit investment in new construction machinery which would not be feasible for a one-year program.

PWA Rescinds Award on Project Blocked by Local Dispute

DETERMINED that local disputes will not be permitted to block the flow of public works funds into the hands of labor and industry, on qualified construction projects, the PWA has announced the rescission of five allotments totaling $190,698, which had been awarded to the board of education of McDowell County, N. C., for school construction. These five allotments were made on December 26, and bond contracts were sent out on January 26.

According to state law, these contracts had to be signed by the board of county commissioners, as well as the board of education. The commissioners have refused to sign the contract agreement in spite of repeated appeals by the PWA. Reports reaching the PWA indicate that the county board has refused to sign the agreement because it was displeased with the appointment of the county school superintendent made by the board of education. The resulting delay and evidence of local dispute blocking this project resulted in the cancellation of the award.

Administrator Ickes has announced the further rescission of 21 previously awarded non-federal allotments totaling $1,840,000. This money has already been re-allotted to other projects. The largest single loan and grant rescinded in this group was the $650,000 award to the Washington Sanitary Commission of Hyattsville, Md., for waterworks and sewer construction. A $307,630 loan and grant to Sheboygan, Wis., for school construction, was also cancelled. The rest of the 19 projects were small.

Increases in seven previously awarded non-federal PWA allotments, and reductions in 11 others, combined with the changing of six loan and grant allotments to grants has resulted in effecting a net increase of $1,121,439 of available PWA money, which has already been re-allotted. The outstanding individual projects in this readjustment of PWA financing was a $299,000 loan and grant to Sioux City, Iowa, for school construction, which has been reduced to $141,000 because of the district's ability to sell $258,000 of its bonds in the open market.

Allotment of $10,000 to the Bureau of Reclamation for financing a survey of the Umatilla River, Ore., has been announced by the PWA. The survey is to determine feasibility of storage on the river for irrigation and flood control, and the PWA allotment will be matched by money raised by Pendleton, Ore., and Umatilla County. An allotment of $48,000 to the Navy Department has been made by the PWA to permit dredging operations in the Hudson River, which will allow the airplane carriers of the Navy to dock at New York.

Conference on the Use of Models Planned at Cornell in June

A conference covering the use of models in research, in design and teaching will be held June 19-21 at Cornell University, Ithaca, N. Y., under the auspices of the Society for the Promotion of Engineering

Education. Three sessions will cover the use of models in the materials and structural fields; these are being planned by E. K. Timby of Princeton University. Three similar sessions covering the hydraulic and sanitary fields are being planned by Fred W. Slantz, Lafayette College, K. C. Reynolds of M.I.T., and Lieut. Herbert D. Vogel, of the Waterways Experiment Station, Vicksburg. George E. Large and Ralph W. Powell, of Ohio State University, are arranging for a group of model exhibits.

All those attending the conference will be housed in dormitories at the university. Reservations are under the supervision of a Cornell committee consisting of E. N. Burrows, E. W. Schoder and H. H. Scofield. Fred L. Plummer, Case School of Applied Science, Cleveland, is general chairman for the conference.

Highway Bill for $450,000,000 Approved by House Committee

A bill authorizing a $400,000,000 appropriation for highways and $50,000,000 for roads in parks, forests, and on the public domain has been approved by the rules committee of the House of Representatives. Two hours debate is to be allowed and the bill may be amended under the five-minute rule. Indications are that the measure will be taken up on the floor early next week.

This bill sets aside indefinitely the limitations on construction through cities and towns and the maximum amount that can be expended per mile. It also postpones any further payment on account of previous advances to states of highway funds. The present bill is a direct grant to the states as aid in providing employment.

In removing restrictions against work through cities the bill corresponds to the provisions of the Recovery Act.

"THOUSAND-SHOT ROCK" on a California mountain highway entrance to General Grant National Park was named because of the care taken to blast the roadway through the boulder without destroying its scenic value.

Washington Notes

By Paul Wooton
Washington Correspondent

Refinancing of insolvent municipalities is provided for in a bill passed by the Senate on May 1. The bill in a similar form has already passed the House. It sets up machinery whereby any town, county or city, if it becomes insolvent within the next two years, may, with the consent of holders of 51 per cent of its securities, file in court a plan of settlement approved by the same percentage of its creditors. If the court approves of the plan it may order its execution provided the approval of two-thirds of each class of security holders is obtained. Somewhat different approval conditions are included in the House bill.

The Administration is trying to launch its housing program without resorting to legislative enactment if the legal obstacles can be overcome by modification. The legal points involved in insuring credit for home repair and home building have been referred to the attorney general. Rediscounting, under the plan, would be through the agency of the RFC.

Penalties for "kick-backs"

Legislation imposing heavy penalties upon contractors on federal projects found guilty of forcing employees to return part of their wages was approved by the Senate. A fine of $5,000, or imprisonment for five years, or both, would be inflicted. The Senate judiciary committee said it had been a common practice for contractors to pay prevailing wages and then force the employee to return part.

Endorsed by the Administration, a bill to reimburse government contractors forced to meet increased costs under NRA codes was favorably reported this week to the House judiciary committee. A board created by the President would have authority to afford relief to contractors who obtained government awards prior to Aug. 10, 1933, and, by complying with code requirements, sustained increased operating costs.

Truck tax protested

Protests by private truck owners against "taxation without representation" was followed by an NRA order this week staying indefinitely the registration of "not-for-hire" vehicles for a fee of 90c. With more than 1 million private trucks on the road, the fee is a large consideration but the basic opposition results from the apprehension that the regulation which the trucking code imposes on "for-hire" operators will gradually spread to private operation.

The outcome of NRA's desire to regiment all trucks will be decided at conferences with the code authorities of the oil, grocery, and other industries under which "not-for-hire" operation is controlled. In the meantime the trucking code authority will be permitted to proceed with collecting a $3 assessment against approximately 500,000 for-hire trucks to cover the cost of code administration.

Tidal power disapproved

The PWA board of review has disapproved the application for $47,000,000 for the proposed tidal power project at Passamaquoddy, Maine, on the ground that it is not economically justified at the present time.

Carl A. Bock Appointed TVA Assistant Chief Engineer

Carl A. Bock has been appointed assistant chief engineer of the Tennessee Valley Authority, and will be in general charge of all engineering activity. Arthur E. Morgan, chairman of the TVA, is chief engineer, having been so designated by President Roosevelt.

Carl A. Bock

Mr. Bock has been with the TVA since its inception, being the first member of the staff appointed by the board after its creation. He served first as co-ordinator, then secretary, and recently has been director of engineering and geology in charge of engineering planning and design and geological investigations.

Mr. Bock graduated from Cornell College in 1906, and worked for several years on railroad location and construction. In 1912 he joined the Morgan Engineering Co., Memphis, Tenn., and since that time has been engaged continuously on water control engineering. He occupied responsible positions in the planning and building of the Miami flood control project in Ohio, and the Pueblo conservancy project in Colorado. For years he has been an advocate of comprehensive coordinated planning for the development and utilization of water resources by drainage areas as working units.

Sherman M. Woodward, who has been acting in the capacity of engineering consultant for the TVA, has been appointed assistant to Mr. Bock. The general engineering and geology division will continue to operate under the direction of Mr. Bock.

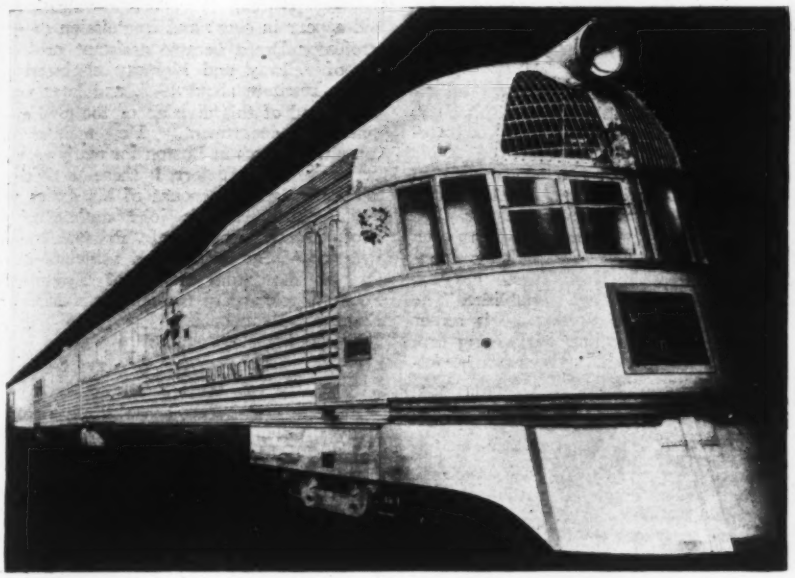
Records of Mississippi River Hydrology To Be Centralized

An office has been established in St. Louis by the U. S. Geological Survey which will serve as a clearing house for all stream flow records and statistics collected on the Mississippi River and its tributaries. This office will centralize all data collected by the various federal agencies and will also keep on file all published records relating to stream flow in the Mississippi Valley.

Burlington Light-Weight Train Is Second Put Into Rail Service

THE second articulated train of light-weight construction to be built in this country was completed recently at Philadelphia and is now on a tour of the country before going to the Century of Progress Exposition at Chicago for the summer. In the fall the train will be put into service on the 251 mile line between Kansas City, Mo. and Lincoln, Neb., a line where a 4-hour service made possible by the train is expected to be an important factor in building up passenger business.

This new Burlington train, like the one built earlier in the year for the Union Pacific System (*ENR*, Feb. 22, 1934) consists of three articulated units propelled by an oil-electric engine in the forward car. Its total length is 197 ft. and the three units are carried on four 4-wheel trucks of conventional type except that rubber is used extensively to insulate the trucks against sound transmission. The total weight is 195,000 lb.



BY STREAMLINING the new Burlington train the wind resistance has been reduced to nearly half that of a standard train when operating at a speed of 95 m.p.h. The Burlington train is designed for speeds up to 110 m.p.h.

The general arrangement of the interior of the train is shown in the accompanying drawing. The passenger capacity is 72 as compared with 116 on the Union Pacific train, the Burlington train having more space for baggage and express, estimated at 50,000 lb.

Both trains are of light-weight construction, the Union Pacific train being of extruded aluminum-alloy shapes and plates while the Burlington train is of stainless alloy steel fabricated by "shot-welding," the structural shapes being formed from thin plates by the shot-welding process. These, generally, are box sections formed by welding a cover plate onto deep-flanged channels. The stainless steel has a tensile strength of 150,000 lb. per sq.in. The car body is nearly tubular in form.

Exterior sheathing is of stainless steel, the panels between the windows being of metal-clad plywood. Insulation is obtained through the use of sheets of crinkled aluminum foil. The interior of the compartments is finished in composition board. The floors are of cork tile except in the mail compartment, where a maple flooring is laid over the cork. Windows are of safety glass. Seats in the passenger compartments have aluminum frames.

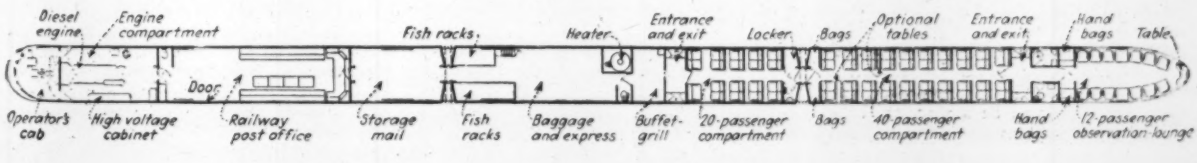
The power plant is oil-electric, consisting of a 600 hp. Diesel engine, built by the Winton Engine Corp., directly connected to a General Electric generator. By the use of welded steel in the engine and engine base the engine weight has been reduced to 22 lb. per hp. Traction motors are mounted on the forward truck. An auxiliary generator supplies current for the air-conditioning equipment, lights, controls and buffet.

Standard Westinghouse airbrake equipment is used, modified to meet the high-speed requirements of the train while still permitting the train to be operated in connection with standard equipment. Aluminum has been used extensively in the airbrake system to reduce weight.

A forced-ventilation air-conditioning system is used throughout and in addition the train is equipped with steam heat from an oil-fired boiler. This heat may be supplied to the passenger compartments directly through copper coils or indirectly through the air supply in the air-conditioning apparatus, or both.

The train is equipped with a small buffet with facilities for serving simple meals, either at the counter adjoining the buffet or removable trays at the seats.

The train was built for the Burlington R.R. at the plant of the Edward G. Budd Mfg. Co., Philadelphia, under the direction of Ralph Budd, president of the C. B. & Q. R. R.



THE THREE UNITS of the new light-weight Burlington train contain the oil-electric engine, mail, baggage and express compartments, and accommodation for 72 passengers.

Vertical Labor Union Formed in St. Louis Building Trades

A vertical labor-union organization to eliminate jurisdictional disputes between individual unions, and a similar organization of contractors, has been formed in St. Louis and the plan has been submitted to the Department of Labor, the PWA, the National Labor Board and other administrative divisions at Washington, D. C., as a model for other communities to follow.

The vertical union in St. Louis is here sponsored by the Allied Building Contractors, which has 300 members. The contractors' body entered into an agreement with Allied Building Crafts Union, which covers the St. Louis area, and at present embraces only building trades, but the plan could be used effectively in other industries, its proponents claim.

The Allied Building Crafts Union has a board of directors composed of a representative of each craft in the construction field. The contractors' body has a similar board. These two boards are to cooperate in settling jurisdictional disputes and similar problems. The new vertical union has no connection with the American Federation of Labor. John J. Collins, chairman of the Allied Building Contractors Association, who has been in Washington on behalf of the new plan, contends that the American Federation of Labor has satisfied neither employes nor employers.

The Allied Building Crafts Union constitution provides that a member may work in any capacity for any employer from whom he can obtain employment, except that he must qualify in one craft division as a skilled journeyman, workman or laborer. He cannot work in his craft below his designation but he may work in any capacity in other divisions. All members are to be paid the scale for the craft in which they are working, irrespective of the craft in which they have qualified.

Corps of Engineers Divides Pacific Coast Organization

The present Pacific Coast division of the Corps of Engineers, U. S. Army, with headquarters in San Francisco, has been divided into a South Pacific division with headquarters remaining at San Francisco, and a North Pacific division with new divisional headquarters established at Portland, Ore. Lieut.-Col. Thomas M. Robins, for several years division engineer of the Pacific Division, San Francisco,, will be division engineer of the newly established North Pacific division with headquarters at Portland, Ore., effective about June 25.

Col. Thomas H. Jackson, at present South Atlantic division engineer, will be the new division engineer for the South Pacific division, San Francisco, effective about July 1. The previous order assigning Col. Jackson to relieve Col. Hoffman as North Atlantic division engineer, New York, has been revoked. Col. James A. Woodruff, district engineer, Philadelphia, will succeed Col. Hoffman as North Atlantic division engineer, effective June 25.

Engineers' Code

(Continued from page 578)

vices or specialized processes or engineering design necessarily adjunctive to and predicated upon the use of particular processes or particular equipment or combinations of the same; nor shall this definition include the engineering services necessarily adjunctive to the operations of a contractor in the peformance of the work called for by engineering plans and specifications.

The present draft recognizes that the functions of an architect and of a landscape architect normally involve certain operations which are included in the definition of engineering services, to an extent limited by the normal training and experience broadly characteristic of these professions. However, an architect or landscape architect, according to the code, when exercising such functions is not intended to be considered and shall not be considered a member of the division as defined by Article 1.

Any failure of a member of the division to pay the registration fee (as described in the previous abstract) within 30 days after the receipt of notice will constitute a code violation provided that the Administrator has approved an itemized budget of expenses of the Engineers' Code Authority, and provided that no protest against such fee has been filed by the member within 15 days after date of notice. The funds collected from these fees shall be used to defray the expenses of the Engineers' Code Authority, and this division's proportionate share of the expenses of the Construction Code Authority, in accordance with a budget of expenses approved by the Administrator.

A new paragraph in the revised draft provides that "No member of this division shall accept an invitation to submit a proposal for his services where such invitation has been issued by advertisement, or by any other method which indicates that price will be a principal basis for selection, except as otherwise required by law." It is also provided that "In all engineering services as defined in Article I, where individuals are placed in positions supervisory of the engineering, and/or positions from which the principles of the engineering may be dictated, such individuals shall be engineers. Delegation of authority by engineers so placed shall be only to engineers or engineering assistants. The term "engineer" and "engineering assistant" were defined in the original revision and in the abstract in the April 5 issue, p. 453.

The section relating to rendering service at less than cost has been changed to read: "No member of this division shall represent that he will provide, nor shall he provide, engineering services free or at less than cost as defined in paragraph (b) of this section, except that he may provide without charge preliminary advisory services prior to an engagement provided the recipient of these services has expressed the intent to engage the member's further engineering service if and when such further services are required for the anticipated construction with which said preliminary services are concerned. In the event that such further services are engaged, the charge shall include a proper charge for the preliminary advisory services."

A new article has been added incorporating the provisions of the Recovery Act relating to collective bargaining but no provision is made for regional boards to handle wage matters.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

PACIFIC NORTHWEST SECTION of the American Water Works Association will meet at Eugene, Ore., May 10-12.

BUILDING OFFICIALS CONFERENCE OF AMERICA at a meeting in Boston April 27 elected Edward W. Roemer, building commissioner of Boston president, Cliff W. Stegner, Cincinnati, first vice-president, James Armstrong, Yonkers, N. Y., second vice-president and William F. Hurd, Indianapolis, secretary. The 1935 convention will be held in Indianapolis.

Daniel E. Moran Honored on Seventieth Birthday

In celebration of a half century of engineering service, and his 70th birthday, Daniel E. Moran was tendered a congratulatory dinner by about a hundred of his friends on April 26. During the past 50 years Mr. Moran has been identified with many of the oustanding foundation jobs of this country and Canada and has been particularly concerned with building foundation problems in New York. He was one of the three men who established The Foundation Co. At present he is senior member of the consulting engineering firm of Moran & Proctor. His response, following the dinner, was "Life begins at 70."

Professor Breed Made Head of Civil Engineering at M.I.T.

Prof. Charles B. Breed has been appointed head of the department of civil and sanitary engineering at the Massachusetts Institute of Technology, after serving as acting head for the past year. He is a native of Lynn, Mass., and after graduating from the Institute in 1897 entered the railroad field, soon becoming attached to the Institute's instructional staff, and later developing a wide consulting practice in addition to his educational duties. He was connected with the engineering departments of the Boston & Maine, Boston & Albany, Chicago & Western Indiana railroads and was also engaged in many municipal and state undertakings as consultant besides being retained by the Massachusetts water board and state harbor and land commission.

He became widely known as a specialist in grade crossing elimination and was called in to investigate many bridge, dam and building projects, to undertake valuations, and appear in court and commission cases. Professor Breed became assistant professor of railway and highway engineering at the Institute about 1907, and later was made head of this division of the civil engineering department. He maintained consulting offices in Boston for many years, but recently transferred these activities to Cambridge on account of his duties at the Institute. He is joint author with Prof. Geo. L. Hosmer of "Principles and Practice of Surveying" and associate editor of the American Civil Engineers Pocket Book and of the American Mining Engineer's Handbook.

Personals

FRANKLIN P. WOOD, consulting engineer, Denver, Colo., has been appointed manager of the federal Subsistence Homestead Projects.

MELVIN O. SWANSON, for the last 13 years superintendent of public utilities of Jamestown, N. Y., has been appointed division engineer for the Tennessee Valley Authority.

JOHN W. KINNEY, engineer of the P. T. Cox Contracting Co., New York, is engineer on the Allegheny River bridge at Tionesta, Pa., being built by the company for the Pennsylvania highway department.

CECIL E. PEARCE, chief designing engineer for the Pasadena, Calif., water department, in charge of design work on the Pine Canyon Dam, and ROBERT L. SMART, of the same department, have resigned to accept positions as assistant engineers with the Bureau of Reclamation, Denver, Colo. Mr. Pearce has been connected with the city project, including dam and conduit, since 1928, and Mr. Smart since 1932.

ALBERT S. LOW has been appointed vice president and chief engineer of the Austin Co., East Cleveland, Ohio. He has been with the organization for 21 years and succeeds Harry E. Stitt, who will continue in the capacity of consulting engineer.

H. L. MEYER, vice president and general manager of the Mason and Walsh Co. (Silas Mason Co., New York, and Walsh Construction Co., Davenport, Ia.) will be in charge of the construction of the diversion tunnels for the Fort Peck dam, on the Missouri River in Montana.

Obituary

HARRY HALL, former Jamestown, N. Y., builder, died April 25 in Albuquerque, N. M. For many years he was with the James G. White Co. on construction work in the Philippine Islands, Cuba and China.

A. R. COOK, retired civil engineer and for many years connected with the engineering department of the Northern Pacific Railway, died recently in Seattle, Wash., age 76.

JAMES B. MCCLAIN, for 28 years a member of the engineering department of the Seaboard Air Line Railway, and for the last 16 years engineer of bridges and assistant engineer of bridges, died in Norfolk, Va. on April 19.

WADE CONVERSE, member of the engineering firm of H. P. Converse Co., Boston, Mass., died April 27 at his home in Auburndale, age 78. He was a graduate of Rensselaer Polytechnic Institute in 1880, and after serving on the engineering staff of the Northern Pacific Railroad for several years, became superintendent of the eastern division. About 16 years ago he joined the Converse Co., of which his brother was president, and was active in the construction of the Commonwealth Pier at Boston, the West Springfield bridge, and the Arlington Memorial Bridge at Washington, D. C.

MERRILL S. SABIN, principal assistant sanitary engineer, Illinois State Department of Public Health, died April 21 at Springfield, Ill. He has been with the department continuously since graduation from the University of Illinois in 1924 and was instrumental in establishing the Central Illinois Water Treatment Plant Operators Association.

JAMES ALLEN, for nine years head of the highway department of the state of Washington, died in Seattle, Wash., April 20, age 63. Leaving the state highway service in 1925, he established the Allen Engineering Co., of Olympia, Wash., which was later changed to Allen & Govan. Mr. Allen is credited with much of the pioneer development of the Washington state highway system.

JOSEPH A. MCELROY, treasurer of the construction firm of McElroy & Kerwin, New York City, died April 28, age 75. Mr. McElroy was connected with construction work on street railway and interurban lines, both in New York, Europe, and other parts of the world. He was a graduate of the Stevens Institute of Technology in 1887.

JAMES A. SMITH, president of the Smith and Brennan Concrete Pile Co., St. Louis, and former building commissioner of that city, died April 26 at the age of 70.

EDMOND W BEASLEY, general contractor, Columbus, Ohio, died in that city April 25, age 62.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING AWARDS total $25,121,000, slightly over the average week to date. Public work totals $19,442,000 and private work $5,679,000. Of the public awards $16,354,000 is by state and municipal authorities and $3,088,000 by the federal government.

Streets and road awards aggregate $9,806,000. Earthwork, irrigation and drainage is high due to a $2,212,000 contract for cement for Boulder dam, and sewerage contracts register the high week for the year in this classification. Public buildings and commercial buildings are low, the former at $1,673,000 and the latter at $778,000.

Larger contracts for the week include a malt plant in Milwaukee $500,000; highway lettings by Wisconsin for cement $990,000, by Virginia for bituminous material $828,000, by Nevada $469,000 and by Georgia $663,000; and intercepting sewers in Columbus, Ohio, $484,000 and in Chicago $1,155,000.

New capital this week is low. Federal reallotments continue as PWA money is released by revisions in previous allotments. The bond market continues strong and bonds are being voted as elections are held. Bond sales for the week at $4,202,000 are under the April average and below the average week to date, but the outlook is good for the continuation of a moderate amount of new financing through municipal bond sales. Corporate issue continues low.

CONTRACTS

(Thousands of Dollars)

	Weekly Average May 1933	Prev. 4 Weeks	Week May 3 1934
Federal Government	$751	$6,577	$3,088
State and municipal	14,360	14,287	16,354
Total public	$15,111	$20,864	$19,442
Total private	4,438	4,434	5,679
Week's total	$19,549	$25,298	$25,121

Cumulative to date:
1933.....$317,327 1934.....$429,359

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

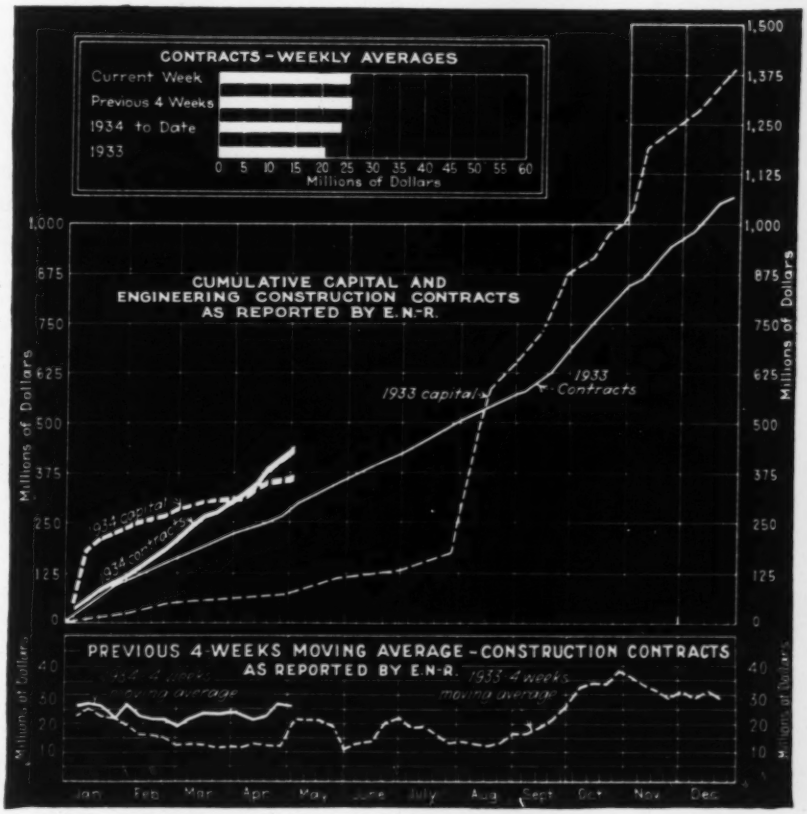
1934	Week May 3	Cumulative
State and municipal	$4,202	$108,177
PWA allotments, S&M	−2,604	189,578
Corporate issues	213	13,582
PWA allotments, private	4,350	49,481
Total, Non-Federal	$6,161	360,818
PWA allotments Federal Constr.	108	49,415
Total new capital	$6,269	$410,233

Cumulative to date:
1933.....$75,781 1934.....$360,818
Rescinded or reduced allotments (from 1933 PWA totals).....$43,323

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

E.N.-R.-Cost		E.N.-R.-Volume	
May, 1934	**199.61**	**April, 1934**	**109**
April, 1934	195.86	March, 1934	108
May, 1933	164.39	April, 1933	65
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		



BUSINESS SIDE OF CONSTRUCTION

Contract Rise Continues in April—Bond Sales Higher, Cost Index Up

ENGINEERING AWARDS for April total $101,192,000, an average of $25,298,000 per week. This is 3½ per cent over March and 105 per cent over April, 1933, on dollar volume. The volume index, which rises only to 109 due to the increase in the cost index, is 68 per cent over last year. Public work accounts for $83,455,000, or 82 per cent of the April total, slightly more than the year's average to date of 80 per cent.

Highways, public buildings and unclassified federal work (including Fort Peck Dam contracts) make the principal contribution to this gain in volume. Both industrial and commercial buildings dropped below last year.

Geographically, west of the Mississippi is the high territory due to the Fort Peck Dam awards; the Middle Atlantic and south are both ahead of last month. All territories are ahead of last year except the far west.

New Capital

The second week in April scored the highest municipal bond sales for new productive capital in more than a year. Even without this record week the average of municipal bond sales per week at $7,040,000 is well above the previous high for the year, $6,156,000. The April average, including the record week, is $12,155,000. With the strong bond market continuing, the movement to transfer PWA loans and grants to grants only also continues. PWA new financing now consists entirely of adjustments of previous allotments, rescissions and the re-allotment of funds released.

Material Notes

Steel prices at Pittsburgh, up from $1.70 to $1.85, dominate the price news for the month. Clay products prices continue unsettled, additional pricing centers report increases this month, while some of the increases reported last month dropped back slightly this month. Lumber price adjustments are numerous. In New York delivered prices are slightly up, although the wholesale price remains stationary. In Minneapolis lumber is up; in Los Angeles prices of the smaller sizes are up, while the heavy construction timbers are down; in Baltimore lumber is generally higher; in Birmingham, lower. Other prices are generally fairly steady.

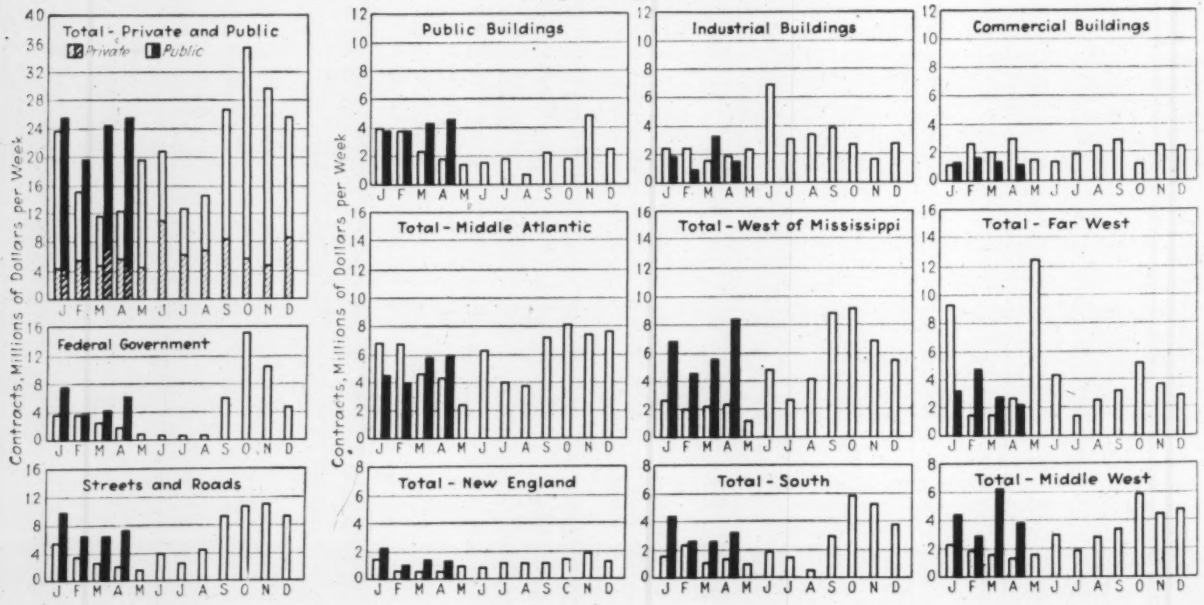
Cement—Portland cement production in March was 5,257,000 bbl. and shipments 4,618,000 bbl. This is an increase of 42.7 per cent and 31.6 per cent respectively over March, 1933. For the first quarter, production is 40.2 per cent and shipments 36.9 per cent ahead of last year. In March the ratio of production to capacity was 23 per cent compared with 20.2 per cent

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN APRIL, 1934

Four Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States April 1934	United States Four Months 1934	United States Four Months 1933	Canada April 1934
Public Works										
Waterworks	115	675	16	1,011	867	369	3,053	16,219	31,099	185
Sewers	392	2,407	559	921	858	5	5,142	15,878	5,894	38
Bridges, public	759	637	355	1,971	3,358	1,057	8,137	34,194	10,463	35
Earthwork and waterways	346	358	2,521	1,529	1,010	1,469	7,233	39,174	19,931	203
Streets and roads	1,242	4,385	5,860	5,908	8,398	4,061	29,854	125,942	57,641	99
Buildings, public	856	6,120	1,577	1,015	8,499	468	18,535	67,133	49,465	....
Unclassified, public	133	1,507	697	61	8,490	613	11,501	24,000	2,956	615
Total public	3,843	16,089	11,585	12,416	31,480	8,042	83,455	322,540	177,449	1,175
Federal gov't (included in other classifications)	591	2,221	4,591	1,949	12,795	2,197	24,344	90,252	49,114	....
Private										
Bridges, private	25	657	35	....	....	....	717	2,583	2,981	....
Buildings, industrial	704	2,552	300	1,128	284	739	5,707	35,798	33,779	200
Buildings, commercial	185	2,042	501	105	1,486	470	4,789	23,233	36,897	....
Unclassified, private	1,107	2,649	370	2,247	13	138	6,524	20,084	12,126	60
Total private	2,021	7,900	1,206	3,480	1,783	1,347	17,737	81,698	85,783	260
April, 1934 (4 weeks)	**5,864**	**23,989**	**12,791**	**15,896**	**33,263**	**9,389**	**101,192**	....	....	**1,435**
March, 1934 (5 weeks)	7,157	29,238	12,887	31,364	27,915	13,643	122,204	....	....	6,074
April, 1933 (4 weeks)	2,400	16,747	5,571	5,243	9,052	10,378	49,391	....	....	5,666
Four months, 1934	25,969	87,018	53,542	76,489	106,482	54,738	....	404,238	....	9,266
Four months, 1933	13,577	93,950	27,269	29,526	38,707	60,203	....	....	263,232	8,295

CONTRACTS REPORTED—WEEKLY AVERAGES—1933-1934



in February and 16.1 per cent a year ago.

Steel—The operating rate of steel companies having 98.1 per cent of the steel capacity of the industry was up to 54.0 per cent for the week ending April 22. March bookings of fabricated structural steel reported by the American Institute of Steel Construction, representing 83 per cent of the industry, showed a marked increase over previous months this year, 13 per cent over January and 40 per cent over February. Shipments for March were 11 per cent and 36 per cent over January and February respectively, but 10 per cent less than shipments in March, 1933. Tonnage ahead for future fabrication shows an increase of 9 per cent over a year ago.

Lumber—Lumber orders received at the sawmills during the first quarter of 1934 were 3 per cent above production, and shipments were 7 per cent below production, according to the National Lumber Manufacturers Association. Production was 58 per cent ahead of the first quarter of 1933, shipments 23 per cent heavier, and orders 29 per cent greater. For the week ending April 14, production was heavier than during any week since last August. New business received was slightly below the preceding six weeks' average.

Labor

Employment in the production of six major construction materials as reported by the Federal Stabilization Board increased in March to 40.9 compared with 39.6 in February and 30.1 a year ago. Adjusted for seasonal trends these figures are 42.1, 41.9 and 31.0 respectively. The Bureau of Labor Statistics, U. S. Department of Labor, reports employment in February on building construction 10 per cent below January. This covers public and private building construction in 34 states and the District of Columbia not aided by public-works funds and not including roads, bridges and other engineering structures.

The common labor wage average is the same as reported the first of April. Skilled labor, however, increased from an average of $1.0841 for three trades to $1.1008. The largest increase was in the iron workers' average, from $1.1216 in April to $1.1541 this month. Bricklayers were next, from $1.1450 to $1.1613. The carpenters' average increased only slightly, from $0.9856 to $0.9869.

Negotiations for wage adjustments are proceeding in many parts of the country. At Rochester the masons, now getting $1.12½ an hour, are negotiating for $1.50, while the contractors are said to be willing to grant $1.20. A mediator is expected to be appointed. Carpenters, now receiving 90c. an hour, have asked for a meeting with contractors in the "expectation" of increasing this to $1.20. At Buffalo, Booth & Flynn, contractors on the substructure of the two Grand Island bridges, agreed to operate a closed shop following a two-day strike by carpenters, hoisting engineers and iron workers. The working schedule of five 6-hour days and the wage schedule are not affected. At Seattle, a basic wage rate of $1.50 an hour for mechanics and $1 for laborers was decided upon by the state conference of building trades. At Cincinnati, effective May 1, bricklayers' wages increased from $1.25 to $1.37½. In Dallas the highway commission voted increases in wages for three classes of skilled labor—iron workers from $0.75 to $1 per hour, carpenters the same and painters, from $0.70 to $0.75. Common labor was fixed at $0.30.

At St. Louis, union carpenters are working on a 4-day, 32-hour week basis to spread available employment. The base wage of $1.25 an hour continues and contractors continue to operate on a 40-hour week. At Philadelphia and Harrisburg the local works division retained the CWA scale for common labor—50c. per hour—and established a maximum work-week of 24 hours. Skilled wages range as high as $1.50 per hour. In Ohio, scattered FERA "strikes" were reported protesting against 35c. per hour for common labor, and the wage was increased to 40c. and union scales for skilled workers. Strikes reported during the month include a carpenter strike called April 19 on the new St. Louis Star-Times Building when the contractors gave the job of laying mastic flooring to cement finishers instead of carpenters. In Washington, plasterers claimed half the job, and bricklayers all of the work of placing stone that was cast on the job by casters belonging to the Operative Plasterers' and Cement Finishers' Union. An effort to settle the dispute by a special committee from the Washington Building Trades Council failed, and the matter is being negotiated by international officers of the two unions. In Kansas City union carpenters and reinforced steel workers on the M.-K.-T. viaduct have been ordered from their jobs because non-union men are employed on the work. This is a PWA project, and the contractors report that workmen are sent to them from the federal re-employment office and that they have no discretion in the employment of men. In Washington a strike of union carpenters was threatened for May 1, which would tie up work on all federal buildings and other union jobs throughout the city. The carpenters want an increase from $1 to $1.37½ an hour and a 6-hour instead of an 8-hour day. Until April 14, 1933, under a union contract, carpenters in the District of Columbia received $11 a day. This contract was superseded by another setting the wage at $8. This agreement, the carpenters allege, was entered into fraudulently. On Sept. 30, 1933, the Assistant Secretary of the Treasury asked the Secretary of Labor to determine, in accordance with the Davis-Bacon law, the prevailing rate of wages for carpenters, and this was found to be $8 as set in the agreement. Secretary Perkins stated, "I was forced by the law to reach this decision regardless of what I might have found concerning the contract which brought the rate down to that level, for the Davis-Bacon law places upon me the duty of determining what the actual prevailing rate is, without regard to the reasons which may have caused it to prevail."

ENR Cost and Volume Index

The *Engineering News-Record* Construction Cost Index for May is 199.61, an increase of 1.9% over March. This is due to the increase in the price of structural steel.

The *Engineering News-Record* Volume Index for April is 109, an increase of .9% over March.

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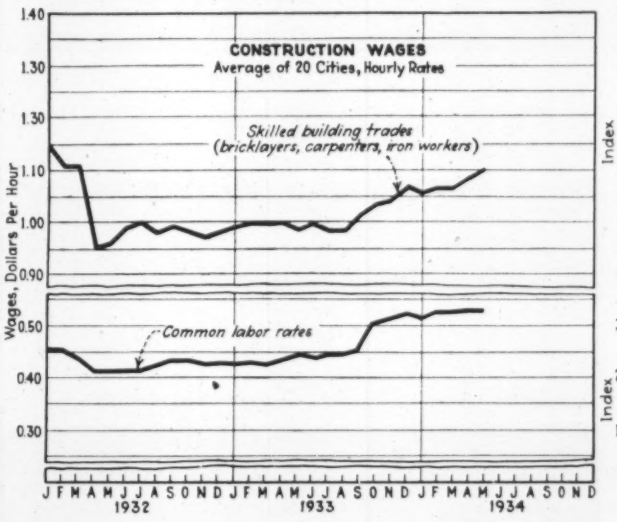

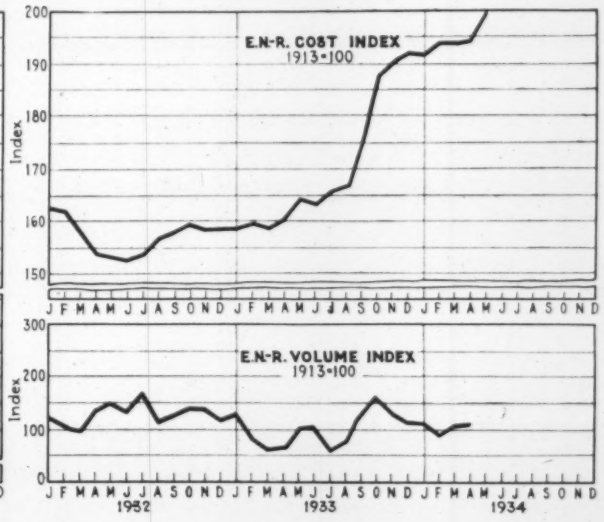

CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE

	PORTLAND CEMENT — Per bbl., carload lots, f.o.b. city, including cost of bags			SAND AND GRAVEL — Per ton, carload lots, f.o.b. city			CRUSHED STONE — Per ton, carload lots, f.o.b. city		CRUSHED SLAG CONCRETE — Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.79	$2.54	$2.34	$2.31	$2.31	$1.64	$1.69	$1.92	$1.69	$1.69	$9.00
Baltimore	2.66	2.41	2.21	1.80‡	2.00‡	1.25‡	1.90‡	2.00‡	2.25	2.25	7.75
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.....	.....	.90	1.15	5.20
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	6.50
Chicago	2.85‡	2.60‡	1.95	1.60‡	1.60‡	1.64‡	1.92‡	1.92‡	.....	.....	.....
Cincinnati	2.57	2.32	2.12	1.30	1.30	1.20	1.80	1.80	.....	.....	6.70
Cleveland	2.45	2.20	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.35	1.35	1.10	2.25	2.25	.....	.....	6.35
Denver	3.60‡	3.40‡	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.15	1.05	.98	1.08	1.08	1.30‡	1.30‡	6.00
Kansas City	2.50	2.25	2.00	.65	.65	.65	1.25	1.30	.....	.....	7.00
Los Angeles	2.90	2.65	.....	1.90	1.90	1.40	1.90	1.90	.....	.....	6.70
Minneapolis	2.75	.....	2.30	1.00	1.00	.25	1.00	1.00	.....	.....	7.00
Montreal	.....	1.70	.....	.....	1.50	1.35	.....	1.25	.....	.....	.....
New Orleans	2.47	2.22	.....	1.70	1.70	1.40	.....	.....	.....	.....	7.75
New York	2.90‡	2.65‡	.....	1.50†*	1.50†*	1.00†*	1.75†*	1.85†*	.....	.....	8.00
Philadelphia	2.60	2.35	.....	2.00‡	2.25‡	1.80‡	1.75‡	2.00‡	1.75‡	1.75‡	6.84
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.25	1.25	8.25
St. Louis	2.42	2.17	.....	1.75‡	1.75‡	1.65‡	1.75‡	1.75‡	.75§	.75§	7.20
San Francisco	2.37	2.17	1.87	1.75	1.75	1.75	1.65	1.65	.....	.....	7.00
Seattle	2.95	2.70	.....	1.50†	1.50†	1.50†	.....	.....	.....	.....	5.75

*Includes 40c. per bbl. for bags, 10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. *Barge lots alongside dock.

CURRENT MILL PRICES CEMENT TO DEALERS, CARLOAD LOTS, F.O.B. MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.65	$1.60	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.60	1.55	Iola, Kans	1.70	1.65	Richard City, Tenn	1.85	1.80
Crestmore, Calif	1.72	.....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.65	1.60
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.60	1.55	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.60	1.55	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.60	1.55

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME

	STRUCTURAL CLAY TILE — PARTITION — Per M, lots of 2,000 pieces or over, delivered			STRUCTURAL CLAY TILE — LOAD BEARING — Per M, lots of 2,000 pieces or over, delivered			BRICK — Per M, in quantity, delivered		LIME — Per ton, in paper, carload lots		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$62.22	$66.38	$124.32	$189.50	$243.20	$277.90	$13.22	$13.50	$17.50	$12.10	$12.10
Baltimore	75.00	80.00	150.00	170.00	210.00	250.00	14.00	17.00	16.00	14.00	18.00
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	3.00§	1.75§	2.25§
Boston	88.40	94.30	176.90	200.40	248.00	283.00	14.00	16.00	17.90	13.60	19.00
Chicago	66.00	70.40	96.80	.....	.....	.....	10.20	11.20	18.00	12.80	12.80
Cincinnati	54.30	67.25	112.50	141.50	186.35	211.75	17.50	17.50	15.97	12.48	.....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	17.50	17.50	19.60k	16.40k	2.65k§
Dallas	74.75	80.00	156.50	156.50	199.75	228.00	13.50	28.00	15.50	14.50	.....
Denver	78.50	88.00	141.50	166.50	196.00	225.00	11.50–15.50	21.00–30.00	30.00	22.00	.....
Detroit	69.50	74.10	139.00	185.70	229.90	284.65	12.00	13.00	20.00	20.00	16.00
Kansas City	63.50	66.00	120.00	160.00	165.00	198.00	12.50	18.00	.60‡,	.50‡,	2.50§
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	.....	18.70	.....	19.70
Minneapolis	77.00	84.00	143.00	165.00	173.00	240.00	13.10	21.00	25.50	21.00	21.00
Montreal	.....	110.00	.....	.....	260.00	.....	15.00	21.50	23.00	13.00	16.00
New Orleans	60.50	64.30	117.90	160.20	195.60	.....	14.00	.....	23.00	12.50	1.95§
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	14.00	.....	20.80	16.00	20.80
Philadelphia	85.90	89.30	167.40	200.80	243.20	301.10	15.00	18.00	16.35	11.25	10.75
Pittsburgh	58.50c	60.00c	115.00c	139.50c	161.00c	193.00c	17.50	22.00	16.69	14.10	16.66
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.10§
San Francisco	68.00	76.50	174.00	.....	.....	.....	14.00	16.00	22.50	21.50	2.05„
Seattle	84.00	95.00	180.00	.....	.....	.....	15.00	17.00	30.00	25.00	3.00§

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl. kLCL. „Per bbl. 180 lbs. cLess 5% cash 15 days.

ROAD SURFACING MATERIALS

	PAVING BRICK AND BLOCKS — Granite per M, lots of 50,000, 4x4x8 in., f.o.b. city	Brick per M, 3x8½x4 in., carload lots f.o.b. city	Wood per sq.yd., 3½ in., 16-lb. treat, f.o.b. city	PAVING ASPHALT — Per ton, less than 80 penetration, f.o.b. city Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, f.o.b. city Tank car	Drums	CUTBACK ASPHALT — Per ton, f.o.b. city Tank car	Drums	ROAD OILS — Per gal., f.o.b. city Tank car	ASPHALT EMULSION — Per gal., f.o.b. city Tank car	Drums
Atlanta	$100.00	$35.00	$2.25	$18.20	$23.41	$0.0726	$0.0989	$20.45	$27.22	$0.0728	$0.105	$0.105
Baltimore	125.00	44.00	2.25	17.00	22.00	.07	.095	.08†	.115†	.....	.....	.....
Birmingham	125.00	24.00	.....	18.00	23.00	0.778	.1028	.082†	.112†	.06	.....	.....
Boston	100.00	32.00	2.25	18.00	23.00	.075	.10	.085†	.12†	.075	.09	.125
Chicago	138.00	42.00	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	100.00	37.00	....	17.40	21.40	.09	.....	18.00	.....	.07	.08	.11
Cleveland	100.00‡	36.00	2.77	18.50	22.70	.0725	.085	.075†	.0875†	.0475	.09	.1025
Dallas	.....	25.00	....	17.60	24.20	.0575	.082	.....	.....	.0575	.15	.....
Detroit	.....	35.50	....	19.67	24.87	.....	.....	17.00	22.50	.....	.....	.....
Kansas City	.....	33.00	2.75	16.00	22.00	.0675	.1005	.09	.13	.065	.08	.09
Los Angeles	.....	50.00	....	12.00	16.00	.....	.....	14.00	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.10	24.60	.098	.098	21.75	34.55	.048	.....	.....
Montreal	.....	100.00	....	14.00	19.66	.07	.093	19.00	26.50	.07	.125	.155
New Orleans	100.00	35.00	....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	135.00§	50.00	2.64	17.00	22.00	.07	.095	.08†	.115†	.065	.085	.12
Philadelphia	100.00	45.00	2.02	15.00	20.00	.06	.....	.07	.10	*.06	.....	.....
Pittsburgh	115.00	40.00	....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	100.00	35.00	2.00	19.50	24.50	.0784	.1111	21.75	29.25	.0398	.09	.125
San Francisco	.....	45.00	....	12.00	18.00	12.00#	18.00#	14.00#	21.50#	.04	.08	.12
Seattle	.....	47.50	....	18.00	23.85	18.00	23.10	15.00	.....	.03	19.20#	34.20#

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudez, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in #Per ton §4x5x9-in. Av

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE Per 100 lb., carload lots	REINF. BARS Per 100 lb., ¼-in. billet, carload lots	RIVETS Per 100 lb., ½-in. structural carload lots	WIRE NAILS Per 100 lb., base, carload lots	SHEET PILING Per 100 lb., base, carload lots	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES Per 100 lb., carload lots: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.00	$2.10	.....	$2.60	.....	$36.375	$35.00	.....	$2.55	$2.40	$1.90	$3.55
Chicago	1.90	2.10	$3.10	2.60	$2.10	36.375	32.00	$31.00	2.55	2.40	1.90	3.55
Pittsburgh	1.85	2.05	3.00	2.60	2.00	36.375	35.00	31.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—LOCAL PRICES F.O.B. WAREHOUSE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price: New billet	Rail steel	EXPANDED METAL LATH Per 100 sq.yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb., base price
Atlanta	$3.34	$2.17	$2.02	$19.50	$22.50	$1.60	$1.21	$0.151	$2.45
Baltimore	2.90	2.70	2.50	18.50	24.00	1.46	1.12	.137	2.65
Boston	3.57	2.83	2.30	18.50	22.00	1.50	1.14	.142	2.32
Chicago	3.60	2.43	.....	20.50	24.00	1.46	1.12	.137	2.00
Cincinnati	3.30	3.10	3.10	25.01	29.50	1.44	1.11	.135	.....
Cleveland	3.06	3.10	2.37	20.00	22.00	1.44	1.11	.135	.....
Dallas	4.00	3.13	2.98	24.50	26.50	1.70	1.27	.161	2.985
Denver	3.29	3.57	.....	23.00	27.00	1.70	1.27	.161	.....
Detroit	3.30	2.635	2.635	18.50	21.50	1.48	1.13	.139	2.165
Kansas City	3.75	2.52	2.63	19.00	20.00	1.54	1.17	.145	2.75
Los Angeles	2.95	2.80	.....	23.00	27.50	1.90	1.40	.18	2.50
Minneapolis	3.35†	2.67†	2.52†	20.50†	24.00†	1.58	1.20	.149	2.40§
Montreal	3.25	3.00	2.80	.....	.....	.....	.....	.....	3.30
New Orleans	3.50	3.00	.....	19.50	23.00	1.58	1.20	.149	.....
New York	3.27	2.52	2.37	20.50	24.00	1.54	1.17	.139	.....
Philadelphia	1.905	2.19	2.04	18.50	22.00	1.44	1.11	.135	2.28
Pittsburgh	1.85‡	1.95†	1.90†	19.10‡	21.90‡	1.44	1.11	.135	2.15
St. Louis	3.34	2.475	2.325	22.25 & 18.50	21.50	1.46	1.12	.137	.....
San Francisco	3.25	3.15	2.95	21.50	24.50	1.90	1.40	.18	2.40
Seattle	3.55	3.50	.....	.....	.....	1.90	1.40	.18	.....

†F.O.B. Customer's Plant. ‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis.

PAINTS AND ROOFING SUPPLIES

	WHITE LEAD Per 100 lb. keg in oil, f.o.b.	READY-MIXED PAINT Per gal., drums, f.o.b.: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$11.50	$1.60	$3.10	.....	$1.74	$2.45	$2.70	$ .36	$23.40
Baltimore	11.00	1.40	2.25	$1.90	1.70	1.60	1.80	.28	24.00
Birmingham	11.50	2.35	2.35	1.85	2.50	2.30	2.10	.55	23.00
Boston	11.00	1.60	2.50	.04½x	2.05	3.50	3.50	.5625	23.00
Chicago	11.00	1.85	2.25	1.25	1.50	1.41*	1.41*	.23	20.00
Cincinnati	11.00	1.40	3.00	1.55	2.40	2.25*	2.25*	.36	25.00
Cleveland	11.00	1.65	2.35	.....	1.50	50.00°	50.00°	.39	19.00
Dallas	12.00	1.80	4.00	1.50	3.15x	2.56	2.47	.36	34.20
Denver	11.75	.....	2.55	.....	2.17	3.00	3.00	.50	30.00
Detroit	11.00	1.55	2.35	1.30	1.50	2.35	2.50	.40	20.00
Kansas City	11.12½	1.65	2.20	1.45	1.75	1.85	2.15	.33	26.75
Los Angeles	10.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	11.12½	.....	.....	.....	1.43	1.34*	1.34*	.2925	23.10
Montreal	9.40	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York	11.00	1.70	2.35	1.48	1.50	1.41*	1.41*	.232	20.00
Philadelphia	11.00	1.50	2.10	1.50	1.50	1.41	1.41*	.232	20.00
Pittsburgh	11.00	1.05	1.95	.80	2.00	1.75*	1.75	.35	24.50
St. Louis	11.00	1.85	2.25	1.25	1.50x	1.41*	1.41*	.24	20.00
San Francisco	10.75	.....	.....	.....	1.83	3.04	.....	.45	26.00
Seattle	10.75	.....	1.92	.....	3.10	4.50	.....	.50	27.60

*New Jersey State Hwy. Spec. 120M. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. °Per ton. §Per 100 lb. *Per roll, 65 lb. xPer lb.
Note: Red lead dry, same as white lead in oil, red lead in oil 50c higher.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928, Single or Double Thickness

	A quality	B quality
Atlanta	85%	85%
Baltimore	88%	90%
Birmingham	89%	90%
Boston	88%	90%
Chicago	87%	89%
Cincinnati	.....	.....
Cleveland	85%	87%
Dallas	85%	87%
Denver	84@ 5%	86@ 5%
Detroit	87@10%	89@10%
Kansas City	89@10%	89@10%
Los Angeles	90%*	90@40%*
Minneapolis	84%	86%
Montreal	.....	.....
New Orleans	88%	90%
New York	87%	89%
Philadelphia	88@10%	90@10%
Pittsburgh	86%	88%
St. Louis	87%	89%
San Francisco	90%	90@30%
Seattle	90@10%	90@20%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases, Gelatin

	40%	60%
Atlanta	$0.215	$0.2375
Baltimore	.19	.21
Birmingham	.105	.120
Boston	.2225	.2375
Chicago	.17	.195
Cincinnati	.22	.245
Cleveland	.19	.205
Dallas	.155	.17
Denver	.19	.205
Detroit	.237	.255
Kansas City	.17	.19
Los Angeles	.1725†	.1925†
Minneapolis	.1725	.1875
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.22	.235
Philadelphia	.215	.24
Pittsburgh	.105	.12
St. Louis	.13	.1425
San Francisco	.1575	.1725
Seattle	.1525	.1675

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, 60 deg., in drums, f.o.b. works, per 100 lb.	1.65
Soda ash, 58%, in bags, per 100 lb.	1.25
Sulphate of aluminum, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb.	3.85

PILES

Prices, per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.11	$0.155
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.15	.20
12 in.—2 ft from butt	6 in.	60 to 69 ft.	.16	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$0.90	$1.20
	Pine, untreated	.90	1.20
	Pine, creosoted	1.35	1.85
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	1.40	1.45
	Southern pine, untreated *6x8x8'6"	1.00*	1.20
	Southern pine, creosoted	1.20*	1.40
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.57	.80
	Fir, creosoted	1.75	2.50
Philadelphia	Red oak, untreated	1.00	1.50
	Red oak, creosoted	1.20	1.85
	White oak, untreated	.90	1.35
St. Louis	Red oak, untreated	.88	1.30
	Red oak, creosoted	1.25	1.85
San Francisco	Sap Pine or cypress, untreated	.75	1.20
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton, f.o.b. 6 in. and over b. & s. class B and heavier, C/L lots*	VITRIFIED SEWER PIPE Per foot, delivered, standard 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONC. SEWER PIPE Per ft., delivered; ASTM Spec. C 14-24 12 in.	24 in.	WROUGHT STEEL PIPE Full std. weight. Discounts from standard list or delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ⅜ in., 9c.; ¼ in., 12c.; ½ in., 17½c.; ¾ in., 23½c.; 1 in., 33c.; 1¼ in., 42c.; 1½ in., 48½c.; 2 in., 59c.; 2½ in., 77c.; 3 in., $1.10; 4 in., $1.94. 1 to 3 in., Butt Weld Black	Galv.	2½ to 6 in., Lap Weld Black	Galv.
Atlanta	$40.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	47%	40%	45%	37%
Baltimore	43.50	.33	.58	2.40	5.25	100.00	170.00	.75	2.00				
Birmingham	36.00	.25	.45	1.625		85.00				48.939%	37.918%	§50.162%	§39.143%
Boston	45.50	.294	.567	1.653	6.97	60.10	101.00	.49	1.85				
Chicago	44.00	.35	.675	2.25	5.125	120.00	200.00	.675	2.25				
Cincinnati	43.00	.224	.432	1.89	5.74	64.29		.40	1.40	57.33%	46.31%	58.55%	47.53%
Cleveland	44.50	.217	.4185	1.845	5.945	47.25	72.00	.536	2.102	59.4%	48.4%	60.6%	49.6%
Dallas	48.00	.27	.485	1.944		160.00	229.00	.46	1.57	67.5%	58.5%	65%	77.5%
Denver	56.00	.23‡	.415‡	1.73‡		100.50‡							
Detroit	44.50	.28	.54	2.25	5.125	100.00	150.00			58.20%	47.50%	56.60%	48.50%
Kansas City	46.00	.35	.55	1.95	3.95	120.00	180.00						
Los Angeles	44.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00				
Minneapolis	46.50	.24‡	.432‡	1.728‡	4.35‡	65.00	120.00			$7.80–35.12	$9.67–43.55	$32.08–74.98	$38.21–90.70
Montreal			1.02	3.64									
New Orleans	42.00	.25	.45	1.62		50.00		.45	1.65				
New York	43.00	.35	.675	2.83	7.48			.55	2.00	56.164%	45.144%	57.389%†	46.368%†
Philadelphia	41.50	.28	.54	1.80		135.00	210.00			56.65%	45.63%	57.88%	46.86%
Pittsburgh	46.00	.217‡	.418‡	1.80‡	5.43‡	46.00	82.00	.75	1.75	64%	55%	63%†	56%†
St. Louis	37.00	.27	.486	1.944	3.96	85.00	172.00	.90	2.28	55.796%	44.76%	57.021%	46.0%
San Francisco	44.00	.25	.45	1.80	4.50	112.00	170.00			60.1%	52.4%	62.4%	53.1%
Seattle	45.50	.35	.63	2.52		84.00	200.00	.50	1.60	60.3%	51.3%	63.3%	52.3%
Burlington, N.J. (base)	40.00												

*Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. †3½ to 6 in. ‡f.o.b. §3½ to 6 in.

LUMBER AND TIMBER

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR Per M ft. b.m., carload lots f.o.b. All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. 1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10 S4S	3x12 Rgh	6x12 Rgh.	12x12, Rgh.	LONG LEAF Y. P. Per M ft. b.m., C/L lots, f.o.b., merchantable grade up to 20 ft. 2x12, Rgh.	12x12, Rgh.
Atlanta	Southern Pine	$20.00	$21.00	$23.00	$19.50	$22.00	$23.00	$28.00			$38.50	$40.00
Baltimore	Southern Pine	27.00	28.00	32.00	31.00	31.00	34.00	41.00			57.00	60.00
	Douglas Fir	30.00	31.00	33.00	31.50	32.50	33.00	34.00	$32.00	$33.00		
Birmingham	Long Leaf	21.50	22.50	23.50	19.50	22.50	23.50	39.50	38.50		42.25	40.25
	Southern Pine	21.50	22.50	22.50	18.50	21.50	22.50	27.75	27.75	27.75		
Boston	Southern Pine	33.00	34.00	41.00†	41.00†	60.00‡	65.00‡	70.00‡			70.00	70.00
	Douglas Fir	32.00	32.00	41.00	41.00	42.00	43.00	42.00	42.00	42.00		
Chicago	Southern Pine	29.00	30.00	35.00	31.00	32.50	34.50	45.00			54.00	58.00
	Douglas Fir	30.50	31.50	33.25	31.50	32.00	30.50	40.75	41.75	41.75		
Cincinnati	Southern Pine	31.50	31.50	31.50	31.00	31.00	34.00	40.00				
	Douglas Fir							47.50	47.50	50.00		
Cleveland	Southern Pine	30.50	31.50	33.50	30.00	32.25	33.00	45.00	44.25			47.00§
Dallas	Southern Pine	36.00	37.80	39.60	41.40	37.25	37.25	52.50			45.25	77.40
	Douglas Fir	37.00	37.00	39.00	39.00	39.50	41.30	56.25	66.15	71.65		
Denver	Douglas Fir		38.00*=	43.50*	43.00*	43.00*	44.50*	44.50*	49.00*			
Detroit	Southern Pine	28.00	29.50	31.50	28.50	31.00	33.00	36.00			33.00	45.25
	Douglas Fir							42.50	45.25	45.25		
Los Angeles	Douglas Fir	31.00	32.00	31.50	30.00	30.00	30.00	34.50	34.50	34.50		
Minneapolis	Western Pine	49.50*	47.00*	43.50*	41.00*	41.00*	41.00*	53.25*¼				
	Douglas Fir	46.50*	47.00*	42.75*	38.00*	38.00*	40.00*	49.75*	50.25*	53.25*	49.50*¼	
Montreal	Spruce	25.00	26.50	22.00	24.00	25.50	32.50	34.50			40.25	
	Douglas Fir	47.50	47.50	42.75	51.25	51.25	57.75					
New Orleans	Southern Pine	26.45	27.70	32.70	27.45	30.45	31.70	43.70			45.20	52.45
	Douglas Fir	28.00	30.00	33.00	28.00	32.00	33.50	37.50				
New York	Southern Pine	35.25*	36.50*	39.00*	35.00*	38.00*Av.	39.00*	47.75			78.50*	77.25*
	Douglas Fir	44.75*	43.00*	43.00*	44.00*	40.00*	42.00*	42.00	40.00*	40.00*		
Philadelphia	Southern Pine	27.50	28.50	30.50	27.25	29.00	30.25	35.00			66.00	64.00
	Douglas Fir			35.50	35.50	35.00	35.00	35.00	35.00	35.00		
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50			57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25		
St. Louis	Southern Pine	38.00*	39.00*	41.00*	37.50*	40.00*	40.50*	53.50*			65.50*	74.50*
	Douglas Fir							57.00*	57.00*	57.00*		
San Francisco	Douglas Fir	28.00	28.00	28.00	28.00	28.00	30.00	29.00	31.00	31.00		
Seattle	Douglas Fir	22.50	21.50	21.50	21.00	22.00	22.50	20.00	20.00	22.00		

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. ¼Northern Pine. ¿Douglas fir. =Native. Av. Average.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.50/.75	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.375	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.00	1.125	1.00	.30	.30
Boston	.90/1.30	.70/1.17½	1.20	.90/1.17½	.90/1.62½	.40/.70	.40/.70
Cincinnati	1.27½	1.02½	1.20	1.07½	1.27½	.45	.40
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.125	1.25	.72	.72
Dallas	1.10½	1.00	1.12½	.75	1.25	.40	.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½		.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.50	.50
Kansas City	1.32½	1.12½	1.12½	1.12½	1.32½	.60 & up	.62 & up
Los Angeles	1.00	.90	1.20	.90	1.00	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	30./.40	.30/.40
New York	1.50	1.42½	1.65	1.50/1.56½	1.50½	.82½	.82½
Philadelphia	.75/1.20	.60/1.20	1.00/1.20	.75/1.00	.60/1.20	.30/50	.30/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78½
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.75	.75
Seattle	1.20	.90	1.10	1.00	1.20	.60	.60
Montreal	1.20	.55	.85	.85	.85	.30	.20

Skilled Ave: (Bricklayers, Carp., Ironworkers) $1.1008. Common Ave. $0.5343 *6-hr. Day.